When You See the Southern Cross...

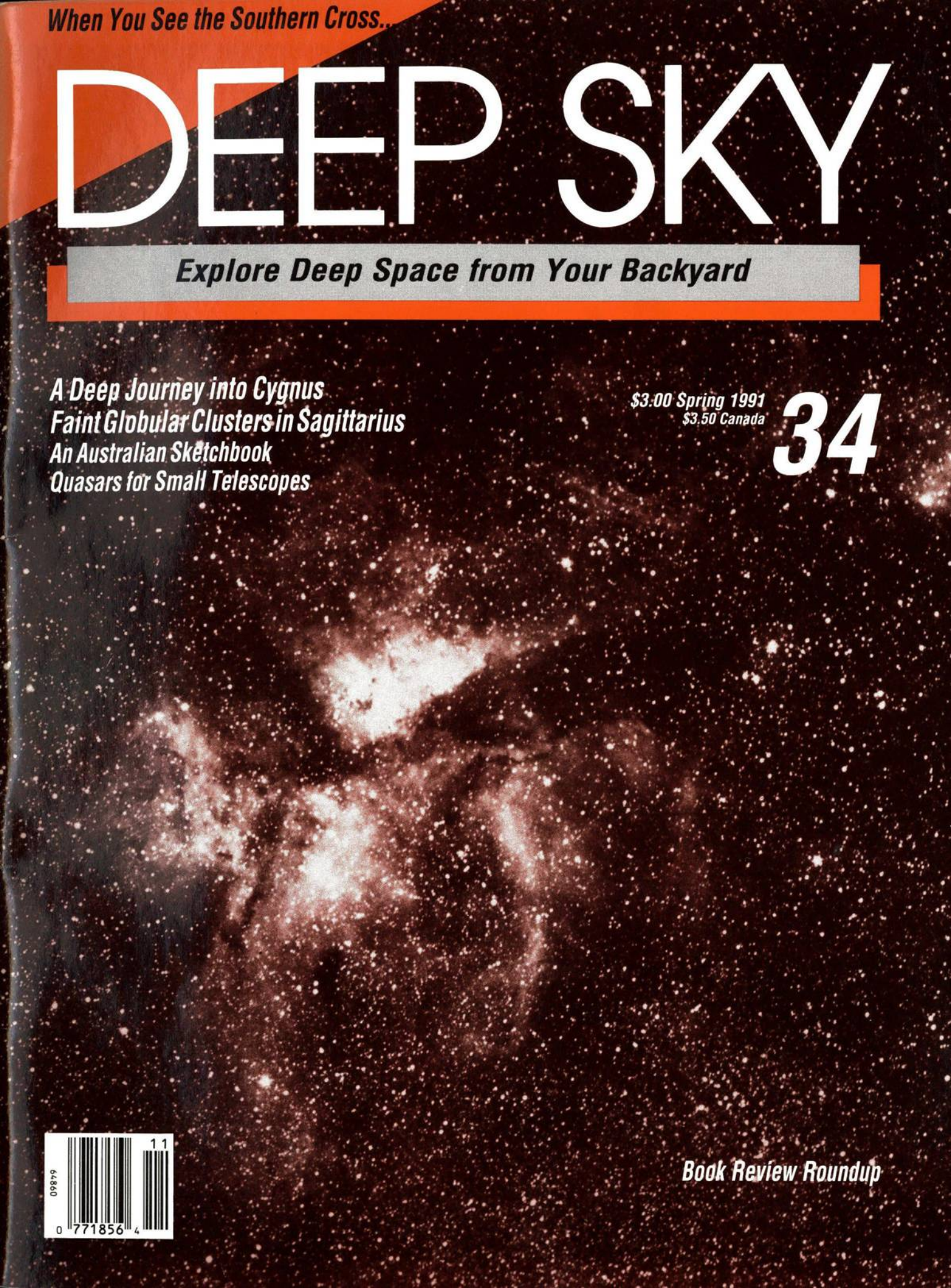
DEEP SKY

Explore Deep Space from Your Backyard

A Deep Journey into Cygnus
Faint Globular Clusters in Sagittarius
An Australian Sketchbook
Quasars for Small Telescopes

$3.00 Spring 1991
$3.50 Canada

34



Book Review Roundup

0 771856 4 11
6980

2" oculars for a wide field and ultra-bright images

Our selection of giant 2" oculars will meet your most critical viewing needs. Nothing beats these big wide field Königs for total viewing pleasure. Full multi-coating and special non-reflective ocular caps.

32mm or 40mm König-2 ..... **$119.95 ea.**
55mm Plössl **$119.95**

The new "Limited Edition" 55mm Plössl

Simply put, we guarantee this new Plössl will equal or exceed the field of view, edge correction, and resolution of any Plössl made regardless of cost, *or your money refunded, no questions asked!* Built-in eye shield and multi-coated. 2" O.D. **$150.00**

This 7-element 40mm König-2 is in a class by itself!

Referred to by some who have used it as the most impressive 2" ocular ever made, the König 7/70 gives an incredible 70 degree field of view with excellent edge of field correction! Standing over 4-1/2" tall and weighing 1 lb. 4 oz., this ocular will be the crown jewel of your eyepiece collection. As with all University 2" oculars, you get state-of-the-art multi-coating and barrels threaded for 48mm filters. **$235.00**

The wide-angle König-2 leads the field in premium quality oculars!

You told us that the König design just couldn't be improved upon, yet our new König-2 series of 1-1/4" oculars have improved multi-coating and darkened lens edges for breath-taking visual contrast. Special non-reflective black ocular caps. Protective caps on both ocular and barrel ends. The 32mm model uses large 2" lenses set in an 1-1/4" format.

6.5mm, 8mm, 12mm, 16mm ..... **$69.95 ea.**
24mm ..... **$74.95 ea.**
32mm ..... **$99.95 ea.**

An improved 12.5mm wireless Plössl for your most demanding guiding requirements

This is the one that started the wireless guiding revolution a number of years ago and this new Plössl design gives a greater field and more eye relief. Double crosshair with 0.25mm central box. Red LED with brightness control. Multi-coated optics. **$99.95**

Excellent quality and reasonable prices make these Plössl and Kellner eyepieces value leaders!

Yes, we still make some excellent quality eyepieces for those of us who don't have $300 or $400 to spend on an eyepiece. Our Plössls are the true 4-element design. The Kellners are parfocal. All eyepieces are multi-coated and threaded for standard filters. 1-1/4" O.D. The **Plössls** are available in **7mm, 12mm, and 20mm—$49.95 ea.** The **Kellners** come in **9mm, 12mm, 18mm, and 25mm—$33.00 ea.**

9mm wireless illuminated eyepiece with movable reticle!

This 9mm Plössl is an astrophotographer's dream come true! Micro-adjusters allow you to move reticle within the field of view. Saves hours of work. Special double crosshair reticle also has two concentric rings. Red LED with brightness control. Diopter adjustment. 1-1/4" O.D. Multi-coated. **$129.95**

The exciting new Wide Scan™ offers the ultimate 80° viewing experience.

Now you can enjoy the 80° viewing experience without the excess size, weight, and expense usually found with this class ocular. And it didn't take us 9 lenses to accomplish it! Beautiful panoramic views, excellent pupil correction, and multi-coated optics for the brightest image of all. Special rubber eyeguards standard on all models. The 25mm model has a 70° field with 7 lens elements. 1-1/4" O.D.

10mm–$130.00, 13mm–$130.00, 20mm–$150.00, 25mm–$150.00

New from University—Wide Scan 32mm 2" O.D. with an 80 degree field!

This exquisite new 6-element Wide Scan 32mm with its wide, flat 80 degree field yields views of the heavens that are simply breathtaking! Fully multi-coated optics for a bright, high contrast image. Try one of these and you will never go back to ordinary eyepieces again. With one giant step, University Optics takes the lead in innovative eyepiece technology. Introductory price **$235.00**

The Klee.™ Not just another Barlow.

Designed by the master opticians who brought you the Pretoria, the 2.8X Klee has earned a reputation among experienced observers as the ultimate in image amplifiers. Only 2-1/4" long due to its unique 3 element air-spaced design. Multi-coated. **$75.00**

Correct confusing views of the sky with our image erectors!

Tired of reversed images when trying to use your telescope and star atlas? We have two beautiful image erecting diagnols that can solve your problem. They also convert your telescope for terrestrial use. The 2" 45° Schmidt prism is multi-coated for maximum image brightness. The 1-1/4" model is of the Amici type and has a 90° viewing angle. A thumbscrew holds your eyepiece securely. Price for the **2" unit is $159.95.** The **1-1/4" Amici is $69.95.**

Deep-Sky Binoculars

These are the excellent quality 80mm binoculars we have been selling for years updated with full multi-coating and BAK-4 prisms. Available in 11 or 20 power, they come complete with case, tripod adapter, and collimation certificate. If you are considering binoculars in this class, please give us a call and get the true story. **11X or 20X–$275 ea.**

Quality filters cut light pollution and enhance planetary detail.

Mark-5 Visual. An extremely high contrast filter for visual use. For areas of extreme light pollution. Gives remarkable results on planetary and emission nebulae. Very narrow bandpass. For 1-1/4" eyepieces—**$75.95**

Mark-5 Photo Visual. This broad band deep-sky filter is great for both visual and photographic use. For 1-1/4" eyepieces—**$75.95**

Variable Density Polarizer. For 1-1/4" eyepieces. Our unit has two glass filters in a rotating cell. You dial the exact density you need—**$32.95**

Color Filters. For bringing out specific planetary features. We offer the most popular colors. **Red, green, blue, yellow, orange, or medium neutral density. $12.95 ea. Full set of six filters—$60.00**

University Optics – for 30 years your source of exceptional quality telescope components

A full line of quality 2" and 1-1/4" diagonals to improve your viewing pleasure.

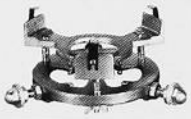
Our star performer is the giant full aperture 2" prismatic diagonal. It seals your primary optical system against dust and pollutants, and the prism surfaces will not deteriorate even after years of use. *We warranty this diagonal to outperform any diagonal made, regardless of cost, or your money refunded, no questions asked!* Price–**$179.00**

For those needing a mirror type, we offer the 2" with a full aperture aluminized mirror. Excellent quality with a cast aluminum body nearly 20% lighter than competitive units–**$110.00**

T-Adapter to fit above diagonals to Schmidt-Cassegrain. **$8.95**
1-1/4" Prismatic Diagonal fully coated **$32.95**
Hybrid Diagonal, fits 0.96, takes 1-1/4" **$39.95**

Use this Foucault tester to check your mirror's figure.

A greatly improved version of the Foucault tester we introduced nearly 30 years ago. All parts cut and fully machined. Simple screwdriver assembly. 0.001" measurement dial. We can only guess how many beautiful 1/20th wave mirrors our testers have helped produce over the years. **Kit—$39.95. Fully assembled–$99.95**



A new concept in lightweight, adjustable aluminum mirror cells.

Made from 100% solid aluminum sand castings, the new open cell design lets your mirror reach thermal equilibrium faster. Mirror carrier is spring-loaded with locking screws. 6" or 8" fits any tube from 6.75" to 10". **For 6" mirror–$24.95. For 8" mirror—$29.95**

University Optics now offers a full line of focusing mounts for every telescope maker's most exacting requirements.

Many telescope owners are surprised to discover that the new complex oculars now on the market can never realize their full potential if their field lenses are tilted off-axis due to sloppy focusing mounts. Our entire line of mounts is now made to yield absolute minimum lateral axial movement.

Vega-1, a rack and pinion focuser for 1-1/4" eyepieces.

Basic construction is aluminum with a chrome plated brass draw tube and helical rack and pinion. 4 tension adjustment screws. Racked-in height is 3". Provision for single vane holder. All hardware included–**$49.95**

The Vega-2 is the perfect match for those large Newtonians.

For years, the first choice of custom reflector builders, the Vega-2 offers a helical-cut rack and pinion, all metal construction, and large 1-1/2" focusing knobs. Takes 2" O.D. eyepieces and comes with a 1-1/4" adapter. Racked-in height is 3-3/4". All mounting hardware included–**$72.95**

The Vega-3 and Vega-5 are precision low-profile focusers.

These two new low-profile helical thread mounts stand only about 1-1/2" high. These are all aluminum construction and each unit has been hand fitted for an oil smooth thread fit. The 2" Vega-3 model is the perfect replacement unit for 1-1/4" devices found on some Dobsonian telescopes. The **2" Vega-3** is priced at **$54.00**. Add **$10.95** if you need a **1-1/4" adapter.** The smaller **1-1/4" Vega-5 is $39.95.**

Vega-4, a new standard of excellence for refractor telescopes.

More and more of the world's finest telescope makers are using this giant 2" Vega-4. Solid brass draw tube with special lock for photographic use. 5-1/4" focus travel. 1-1/2" focusing knobs. 4 tension adjustment screws. Fits into 3.09" mounting hole. Complete with 1-1/4" adapter–**$125.00. Aluminum end plates for Vega-4.** Fit standard 0.05" wall tubing. **3", 4", 5", or 6"—$25.00 ea.**

Yes, we have telescope counterweights by the ton!

We are now offering our own cast iron counterweights and since they are made here in the U.S.A., we can save you a "ton" of money. We bore to your shaft size at no extra cost. Tightens on your scope with 1/4-20 locking bolt. **5 lb–$19.95, 10 lb–$29.95, 50 lb–$69.95.** Weights are F.O.B. Ann Arbor, Michigan. Call toll free for exact UPS charges to your door.

80mm Refractor Kit.

This astronomical quality kit features a high performance air-spaced multi-coated lens with a 500mm focal length. Uses our Vega-4 2" focuser. All parts beautifully machined of brass and aluminum. Screwdriver assembly in about 15 min. Warning! Don't put this scope next to similar size scopes selling for three or four times our modest price. The other owners will be very unhappy! No eyepiece or diagonal supplied–**$289.95**

Castings for German Equatorial Mount.

We have a set of 4 unmachined aluminum sand castings designed for 1-1/2" shafts. You'll need a 10" or larger lathe to machine them. Price **$250.00** F.O.B. Ann Arbor.

New 100mm Refractor Kit

Yes, our new 100mm refractor kit is here just in time for the prime viewing season. Everything is the same as our popular 80mm kit listed above only with 100mm lens and 550mm f.l. **Introductory price $495.00**

Postage and Handling

Merchandise Total with Shipping Charge			
Up to $69.95	$2.95	$100.00 to $199.99	$4.95
$70.00 to $99.99	$3.95	$200.00 to $299.99	$5.95
		$300.00 and up	$6.95

HOW TO ORDER

Free Catalogue–If you would like our full 32-page catalogue, we will send it free via 3rd class mail. If you wish it 1st class, please send $1.00. Catalogues outside the U.S.A. are $3.00.

Mail Order–Simply write us a letter with your requirements. Payment via VISA, MASTERCARD, personal check, or money order.

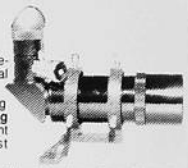
Guarantee–It has been our policy for the last 30 years to always offer a money-back guarantee on all our items.

All prices and specifications in this ad are subject to change without prior notice. Our phone numbers are **313-665-3575** and **800-521-2828**. Hours are 9:30 a.m. to 7 p.m. EST, Monday thru Saturday.

Orders and Questions FREE
Toll Free **800-521-2828** 32 page Catalogue

University Optics Inc.
P.O. Box 1205 Ann Arbor, MI 48106

Our 8x50 viewfinders help you locate objects quickly and accurately.



Our 8x50 finders come with a 1-1/4" wide-field eyepiece and diagonal. All-metal construction. Fully coated optics.

Choice of white or black. Mounting bracket is extra. **Price–$99.95. Mounting bracket** for above finder with 6 adjustment screws fits C-8, 2080, and most reflectors–**$19.95**

Illuminated Model. 8x50 with a wireless illuminated eyepiece gives you perfect polar alignment using special etched glass reticle. Eyepiece has rubber eyeguard. Black finish only. This unit comes complete with mounting bracket–**$159.95**

Our 11x80mm is the "ultimate" giant viewfinder!

It's a fantastic viewfinder. It's a versatile rich-field telescope. It's a compact nature study scope. It has an Amici prism for correctly oriented images. We added a fine quality rack and pinion, a crosshair eyepiece, and a camera tripod mounting block to round out the package. Beautiful satin black finish—**$279.95**

Our binocular viewer lets you use both eyes for increased visual acuity!

Our years of experience supplying binocular viewers assure you the finest product on the market. Our unit features the exclusive removable multi-coated Barlow image transfer lens system. Our unit fits any 1-1/4" telescope. Interpupillary adjustment with indexed scale–**$475.00**

Parabolic Mirrors—our Master Optician Series™ will meet your most exacting requirements.

Let's forgo the usual ad writer's hyperbole concerning mirror quality and simply say that if these are not the finest quality telescope mirrors you have ever seen, return them and *we will refund your money, no questions asked!* The best part is we can usually give off-the-shelf delivery when you are in a hurry to start your telescope. **Available in 6" f/5, 6" f/8, 8" f/6, and 10" f/6. Please call for prices.**

Accessories for Schmidt-Cassegrain Telescopes.

Camera quality visual and photographic accessories for your Meade or Celestron telescopes. **T-adapter–$27.95. Telextender–$27.95. Telecompressor** (larger 36mm size with extension tube)–**$56.95, Deep-sky f/5 Visual Adapter–$89.95, Off-axis Guider Body only $65.95**

The latest Willmann-Bell publications.

All book prices are postage-paid.

Uranometria 2000.0 Volume 1 ..... **$39.95**
Uranometria 2000.0 Volume 2 ..... **$39.95**
Astro Formulae for Calculators. Meeus **$14.95**
Microcomputer Control of Telescopes. Trueblood and Genet **$19.95**
How to Make a Telescope, 2nd Edition. Texereau **$19.95**
Astrophotography. Gordon **$18.95**
Astrophotography II. Martinez **$18.95**
Advanced Telescope Making Techniques, Volume I **$19.95**
Advanced Telescope Making Techniques, Volume 2 ..... **$19.95**
Telescope Optics, Evaluation and Design. Rutten and VanVenrooij **$24.95**
Introduction to Observing and Photographing the Solar System. Dobbins, Parker, and Capa **$19.95**

Pretoria™—is this perhaps the world's first professional telescope ocular?

The October 1988 product review in *Astronomy* states: "If you are looking for the perfect eyepiece for your fast Newtonian reflector, the Pretoria eyepiece is it." While the Pretoria does eliminate coma in fast Newtonians, it can dramatically improve the performance of any Newtonian. 25mm of eye relief in the 28mm model for those who must wear glasses. Multi-coated optics. For 2" or 1-1/4" holders.

28mm **$225.00**

Exciting new additions to the Wide Scan™ lineup!

We have some new additions to the world's most exciting line of compact, lightweight, and affordable 80° plus eyepieces. The new **16mm** with an 84° field gives a brilliant performance. All **Wide Scans**™ feature only the finest select Japanese optics throughout. Full multi-coating. The 82° field **6mm** and **8mm** will be available in the summer of 1990.

16mm...$140.00, 8mm...$125.00, 6mm...$125.00

A wide variety of adapters to help you get the most from your telescope

Professional Camera Adapter couples your camera to any 1-1/4"" focuser. For first focus and eyepiece projection. Use with camera T-ring listed below—**$34.95**

For Imported Scopes. Same high quality as above but fits 0.96 telescope–**$29.95**

2" Prime Focus Adapter. For prime focus in 2" systems. You do need aT-ring for your camera–**$24.00**

ORDER FORM

QUANTITY	DESCRIPTION	PRICE

Charge My: ☐ VISA ☐ MasterCard

CARD EXPIRES: MO. YR.

SUB TOTAL $ _____
HANDLING _____
MI—add 4% Tax _____
TOTAL $ _____

CHARGE CARD NUMBER:

CARD HOLDER NAME

CARD HOLDER SIGNATURE

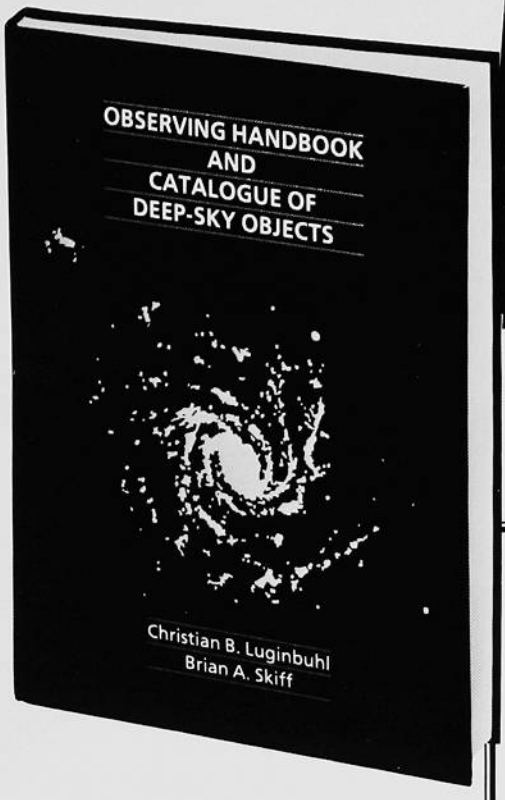
NAME

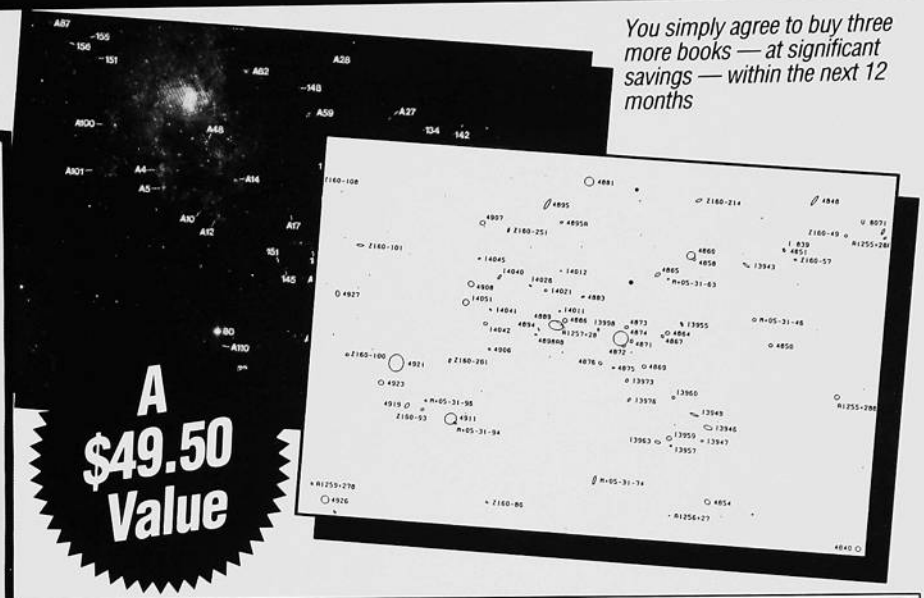
ADDRESS

CITY STATE ZIP

Observing Handbook and Catalogue of Deep-Sky Objects yours for only $1.00

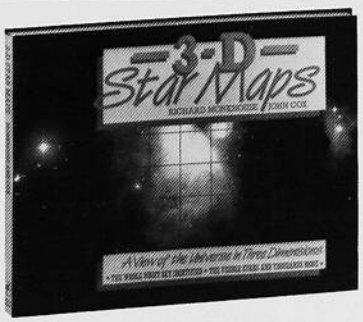
as your introduction to the **Astronomy Book Club**





A $49.50 Value

You simply agree to buy three more books — at significant savings — within the next 12 months



PLUS, 3-D Star Maps & Glasses FREE —A $15.95 Value—

3-D Star Maps goes one step beyond traditional star maps to show you the universe in three dimensions. Use the free red-green glasses to see more than 10,000 stars and galaxies, as they appear in the night sky. Black-and-white maps, identifying the stars and galaxies, accompany the 33 three-dimensional star maps.

Over 2,000 deep-sky objects ...

Here is the ultimate reference for amateur astronomers looking for practical guidelines and information on observing deep-sky objects.

Over 2, 050 galaxies, star clusters, nebulae, and constellations, some detailed for the first time, have been systematically viewed and charted here with dimensions, magnitudes, orientations, and angular distances to help you find and observe them. Plus, the catalogue section of the book contains single-line data entries on almost 3,000 deep-sky objects.

Observations are grouped by constellations in alphabetical order. Actual visual descriptions, in order of three increasing telescope apertures commonly used by amateur astronomers, are provided. Finder charts are included to help with identifying objects in particularly crowded or confusing fields. Six of the brighter clusters of galaxies are also mapped.

Just complete and mail the postage-paid reply card today to get the Observing Handbook for only $1.00 and 3-D Star Maps Free.

MEMBERSHIP BENEFITS • In addition to getting Observing Handbook and Catalog of Deep-Sky Objects for only $1.00 and the 3-D Star Map for FREE when you join, you'll also receive discounts on books you choose to purchase. Discounts generally range from 15% to 30% off the publishers' prices, and occasionally even more. • Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings of 60% off the publishers' prices. • At 3-4 week intervals (15 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • In addition, up to two times a year, you may receive offers of Special Selections which will be made available to a group of select members. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

© Newbridge Communications, Inc.

Astronomy Book Club L-CX9

A Division of Newbridge Communications, Inc.
3000 Cindel Drive
Delran, New Jersey 08075

Please accept my application for trial membership and send me the Observing Handbook (65182) billing me only $1.00, plus shipping and handling and send my free 3-D Star Maps and Glasses (84274). I agree to purchase at least three additional Selections or Alternates over the next 12 months. Savings generally range from 15% to 30% off the publishers' prices. My membership is cancelable any time after I buy these three additional books. A shipping and handling charge is added to all shipments.

No-Risk Guarantee: If I am not satisfied—for any reason—I may return the Observing Handbook within 10 days. My membership will be canceled, and I will owe nothing.

Name _____

Address _____ Apt. ____

City _____

State _____

Zip _____

(Books purchased for professional purposes may be a tax-deductible expense. Offer good in Continental U.S. and Canada only. Prices slightly higher in Canada.)

Deep Sky 3/91

DEEP SKY

THE MAGAZINE FOR DEEP-SKY OBSERVERS AND ASTROPHOTOGRAPHERS
FOUNDED IN 1977 BY DAVID J. EICHER
SPRING 1991 VOLUME 9, NUMBER 2

12 To See the Southern Cross
by Tom Polakis and Brian A. Skiff
Discover the joy and beauty of the southern Milky Way — an area comprising sights completely unrivalled by the north!

16 Exploring the Cygnus Nebulosity Complex by Chris Schur
An experienced Arizona astrophotographer takes you on a journey deep into the faint nebulosities of Cygnus the Swan.

24 Discover the Unknown Globulars of Sagittarius
by Robert Bunge
Sure, you've seen M22, M55, and M70, but how many of these tough little buggers can you claim as entries in your observing notebook?

8 At the Eyepiece

8 Letters to *Deep Sky*

32 *Deep Sky* Reports
The "Deepest" Deep-Sky Objects
Revisiting the Australian Sketchbook
Spring's Challenging Deep-Sky Objects

42 *Deep Sky* Reviews
A Universe of Words

46 Small Scope Showcase
Dwarf Galaxies for "Dwarf" Telescopes

48 Double Stars
A Survey of Cancer

50 Scanning the Literature
Galaxies and Their Magnitudes, Part Four

Cover: NGC 3372 photographed by Jean Dragesco with an 8-inch f/1.5 Schmidt camera, hypered Tech Pan film, and a 5-minute exposure.
Opposite page: The Southern Milky Way photographed by Martin C. Germano with a 50mm f/4 lens, hypered Tech Pan film, and a 25-minute exposure.

Editor-in-Chief
David J. Eicher
Managing Editor
Rhoda I. Sherwood
Editorial Secretary
Tracy Staedter
Art/Design Manager
Patti L. Keipe
Senior Contributing Editor
Brian Skiff
Contributing Editors
Richard Berry
Robert Bunge
Robert Burnham
Mark J. Coco
Rick Dilsizian
Alan Goldstein
Phil Harrington
David Higgins
Alister Ling
Robert Reeves
Chris Schur
Gregg D. Thompson
F. Michael Witkoski

Publisher
Robert A. Maas
Art Supervisor
Thomas L. Hunt
Circulation Director
Charles Post
Group Advertising Manager
Daniel R. Lance
Advertising Sales Manager
Greg Swan
Ad Sales Representative
Catherine Odland

DEEP SKY magazine (ISSN #0735-307) is published quarterly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Copyright 1991 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without written permission. Second class postage paid at Waukesha, WI and additional offices. POSTMASTER: Send address changes to DEEP SKY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Direct all inquiries, editorial submissions, complaints, and other correspondence to the above address. Telephone (414) 796-8776. The opinions expressed in this magazine are not necessarily those of the publisher or editors. Kalmbach Publishing Co. cannot be responsible for unsolicited materials. Names and addresses of authors may be published unless specifically requested otherwise. Questions about subscriptions: (800) 446-5489 weekdays 8:30 a.m. — 5:00 p.m. Subscription price (U.S.): 1 year $12, 2 years $21, single issue $3; (elsewhere): 1 year $14, 2 years $25, single issue $3. U.S.A. Newsstand Distribution by Eastern News Distributors, Inc., 250 West 155th Street, New York, NY 10019. Clubs and dealers: inquire about bulk rates.

Orion Is America's #1 Source For Telescopes & Binoculars!

Only a Fraction Of Our Products Can Fit In This Ad.

Our Winter-Spring 1991 catalog is full of hundreds of name-brand telescopes, binoculars, eyepieces and accessories, plus page after page of helpful reference information to make your hobby more enjoyable. Whether you're an "old hand," or you're just starting out in amateur astronomy, Orion has top quality products for you, all at our famous low discount prices. Everything you buy from Orion includes our super service and satisfaction guarantee. Find out why Orion has been America's #1 source for telescopes, binoculars and accessories since 1975

CALL TODAY FOR YOUR FREE CATALOG!

Orion® UltraScan™ 80 Wide Field Refractor

ED Glass Virtually Elimates Chromatic Aberration

Orion's hottest new addition is this 80mm f/6.25 Super-ED Achromat refractor! One of Japan's most famous lens makers designed this 2-element optical system with high performance ED glass. The unobstructed optical system gives breathtakingly sharp, high contrast images at a wide range of magnifications. It is equally suited to wide field scanning at an incredibly low 12.5x or high-magnification observation at 150x (or more), with standard oculars. The superbly crafted rack-and-pinion focuser has a full 2" diameter chrome-plated brass drawtube and aluminum threaded eyepiece holder that accepts 1.25" accessories. Remove the 1.25" eyepiece holder and you may fit an optional 36.4mm threaded camera adapter. Includes achromatic 6x30 finder scope in adjustable mounting bracket. The 1/4-20 tripod mounting block fits all standard photographic tripods. Eyepieces, tripod, and diagonal prisms are sold separately, allowing you to configure the UltraScan 80 to meet your exact needs.

NEW!

#9080 **$449** (6.77)

Shown with optional tripod and Giant 2" Astronomy Accessory Package

Giant 2" Astronomy Package

Includes 2" focus adapter, our great 2" mirror star diagonal prism and popular 2" 32mm Erfle eyepiece, for 16x magnification. (Special package price with purchase of the UltraScan 80.)

#21116 **$199** (4.89)

America's #1 Source For Major Brands!

Orion® Big Eye 8x50 & 11x80 Finder Scopes

NEW!

Ideal for upgrading any telescope including Schmidt-Cassegrains. Available non-illuminated or with wireless, adjustable, battery-operated illuminated reticle and Polaris grid for accurate polar alignment. With 90° diagonal prisms. Optional deluxe dual-ring brackets are perfect for 8" and 10" Celestron or Meade; will fit many others, too.

8x50 Models
The 50mm objectives gather 2.7 times more light than 30mm finders!

8x50 Standard Finder #7100 **$89.95** (3.31)

6x50 Illuminated Finder #7135 **$134.95** (3.56)

Bracket— For 8" & 10" #5143 **$25.95** (1.89)

11x80 Models These huge finders gulp in over 7 times the light of 30mm finders; 2.5 times more than 50mm models! You might spend more time viewing through the finder than through your main telescope!

11x80 Standard Finder#7146 **$219** (4.16)

11x80 Illuminated Finder #7143 **$269** (4.16)

Bracket— For 8" & 10" #5140 **$37.95** (2.39)

SuperGiant™ 14x100 Binoculars

NEW!

Gigantic 100mm (almost 4 inch!) lenses gather 156% of the light of 80mm binoculars. Individual eyepiece focus improves alignment and allows for more precise focus. They feature Fully Multi-Coated optics and BAK-4 prisms. Comes with the integral platform tripod mounting plate and metal-clad case. 14x magnification, field of view 3.3°, exit pupil 7.0mm, weight 7.5 lbs., height 13.5".

#9495 **$799** (12.95)

Orion® Enhanced™ Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars. Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC- Brightest, widest-field available. Ideal for deep-space observation under dark skies. Hand-holdable.

#9502 **$349** (6.43)

16x80 MC-45% higher power, excellent for astronomy and daytime observation. Tripod recommended.

#9496 **$379** (6.43)

20x80 MC- Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required.

#9498 **$389** (6.43)

Orion® Little Giant™ 9x63 Roof Prism Binoculars

Popular mid-sized binocular. Fully Multi-Coated and remarkably lightweight. Excellent contrast and sharpness at center of field, with enough power to see lunar craters & Jupiter's moons. 5.5° field of view. Weight 2.8 lbs.

#9500 **$199** (4.80)

Orion® Sky Explorer™ Mini Deep Sky 8x56 Binoculars

56mm objective lenses gather over 2.5x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects, daytime viewing. Best Multi-Coated BAK-4 optics. 6° field of view.

#9504 **$139** (4.16)

Superior Performance 7x50 Adlerblick Binoculars

Incredible wide field eyepiece design. Fully Multi-Coated, BAK-4 prisms, and best special glass objective lenses make the 7x50 Adlerblick the archrival of European brand binoculars selling for 3-4 times the price. Orion buys direct, saving you money. Includes deluxe hard case, lens caps, straps.

#9612 **$269** (4.16)

Orion® 7x50 Observer™ Binoculars

NEW!

Our new Observer binocular is an ideal moderately priced night-vision binocular for both astronomy and general purpose daytime observation. Fully coated optics with a 7° field of view, and a bright 7mm exit pupil. Rugged ribbed rubber covering for a good grip.

#9620 **$84.95** (3.66)

StereoScope™ Binocular Viewing Expander

NEW!

Open up a new dimension in observation! The stereo effect of this viewer is astonishing. Viewing is more comfortable and it shows more detail, especially of the moon and planets. Specially built for astronomical telescopes, features a fully adjustable 55-75mm interpupillary distance scale and a highly precisce beam splitter which maximizes transmission of light to each eyepiece and equalizes the brightness of each image. Threads securely onto any Celestron or Meade Schmidt-Cassegrain. Includes a thread-on matched 2x Barlow lens. (Shown with two eyepieces, not included.)

#9720 **$399** (3.79)

Orion® 12.5mm Plössl Illuminated Reticle Eyepiece

This new 12.5mm 4-element Plössl offers unprecidented eye relief and observing comfort during long astrophoto exposures. The battery operated integral illuminator has fully adjustable brightness. Features double crossline reticle.

#8484 **$99** (2.79)

World's Finest Illuminated Reticle Eyepiece

6mm Orthoscopic design for required high-power guiding, plus unique X-Y adjustable reticle positioning for easy guide-star alignment. Wireless LED illuminator has adjustable brightness.

#8487 **$139** (2.79)

Orion® 9mm Orthoscopic Illuminated Reticle Eyepiece

9mm Orthoscopic eyepiece with wireless adjustable brightness illuminator. Bull's-eye within three concentric circles helps measure limits of acceptable guiding error.

#8488 **$119** (2.79)

Orion® 12mm Kellner Illuminated Reticle Eyepiece

12mm Kellner eyepiece with cable plugs into LX/3, LX/5 and Premier drive bases, and most drive correctors with illuminated reticle output for polar alignment and guiding.

#8482 **$69.95** (2.59)

Orion® 2" Barlow Lens

NEW!

2x magnification, Multi-Coated, 2-element 40mm diameter achromatic lens. Baffled to eliminate off-axis glare. Works with all 2" barrel diameter eyepieces. Chrome plated brass barrel and blackened aluminum body with knurled set screw.

#8720 **$69.95** (2.59)

Orion® VariPower™ 2-3x Multi-Coated Barlow Lens

Our best barlow offers significant improvement over other models we've seen. The magnification is adjusted by sliding the internal lens cell along a calibrated scale (you don't have to poke a finger or pencil inside to do this). Fully Multi-Coated optics provide excellent sharpness, contrast and brightness. 1.25" diameter.

#8748 **$69.95** (2.59)

Orion® 3-element Fully Multi-Coated Barlow Lens

Fully Multi-Coated 3-Element Barlow lens provides superior imaging with precise color correction at three wavelengths. For maximum light transmission and highest contrast, we have used the finest quality multi-coating on each air to glass surface. 1.25" diameter.

#8750 **$59.95** (2.59)

Orion® Deluxe Fully-Baffled Multi-Coated Barlow Lens

Fully internally opaqued and baffled to block stray light for noticeably higher contrast. Large 27mm multi-coated 2-element lens provides 2x magnification with any 1.25" eyepiece.

#8746 **$49.95** (2.39)

100% Satisfaction
Money-Back Guarantee
If you are not completely satisfied with your purchase from Orion, for any reason, just return it in new condition within 30 days after delivery for a full refund.

ORION TELESCOPE CENTER

CALL TOLL-FREE
800-447-1001
In Calif. 800-443-1001
General Offices 408-464-0446

77° Field UltraScan Wide-Angle Eyepieces

NEW!

Unlimited visibility is yours with up to 77 degrees of field to catch your eye. High quality optical materials and superb coatings, for the ultimate in contrast and resolution.

1.25" UltraScan Eyepieces

Five optical elements utilizing the latest high refractive-index optical glass materials achieve extremely wide fields with fewer elements than many competitive eyepieces, reducing weight and cost. Each lens surface is fully Multi-Coated, for the ultimate in contrast and elimination of stray reflections. Integral rubber eyeguards.

9mm #8420 **$99** (2.79), *12mm* #8421 **$109** (2.79)
15mm #8422 **$129** (2.79), *19mm* #8423 **$139** (2.79)

2" UltraScan Eyepieces

These incredible oculars provide breathtaking panoramic, bright views that will astonish you!

30mm 2" UltraScan Eyepiece–This 5-element, 77 degree field UltraScan eyepiece combines the widest possible apparent and true fields with a larger image scale than our 40mm.

#8424 **$199** (2.79)

40mm 2" UltraScan Eyepiece - Orion's brightest, widest true-field UltraScan eyepiece utilizes a sophisticated 7-element design, providing a 68 degree apparent field; the widest we could fit into the 2" diameter barrel.

#8425 **$179** (2.79)

High Resolution Orion® Ultrascopic Eyepieces

Unlike other premium eyepieces, Orion Ultrascopics offer complete multi-layer coatings on ALL surfaces, for superior light transmission and contrast. Modern 5- and 7- element designs for pinpoint star images and breathtaking detail. Wide 52° field of view. Compare with other brands selling for much more!

Wide Field 5-element

35mm #8560 **$89.95** (2.59)
30mm #8562 **$79.95** (2.59)
25mm #8564 **$64.95** (2.59)

Medium-High Power 5-element
20mm #8566, 15mm #8568, 10mm #8570, 7.5mm #8572
$59.95 ea. (2.59)

High-Power 7-element 5mm #8574, 3.8mm #8576
$79.95 ea. (2.59)

Orion® MegaVista™ 1.25" Wide Angle Eyepieces

Incredible Fully Multi-Coated high-transmission 7-element eyepieces with integral rubber eyeguard and long eye-relief.

10.5mm– An incredible 67° field for outstanding planetary or deep space performance.

#8552 **$109** (2.79)

16.8mm–Outstanding high-contrast eyepiece with stunning 70° field ideal for deep space.

#8554 **$119** (2.79)

Orion® UltraZoom™ 7-21mm 1.25" Eyepiece

The finest zoom you can buy for your 1.25" telescope. An excellent choice for astronomy or terrestrial observing. 65°-35° field.

#8556 **$129** (2.79)

Orion® Explorer Series 1.25" Eyepieces

Remarkably affordable, Multi-Coated parfocal eyepieces with great performance. Each carefully selected series has been chosen to provide a sensible progression of magnifications. Threaded for filters. Internally blackened to prevent stray light reflections.

Kellner Eyepieces–
6mm #8536, 9mm #8538, 12mm #8540,
18mm #8508, 25mm #8510, 40mm #8512
$33.95 ea. (2.19)

Orthoscopic Eyepieces–5mm #8500, 7mm #8502, 9mm #8504, 12.5mm #8506, 18mm #8524, 25mm #8526
$46.95 ea. (2.19)

Orion® Explorer Series .965" Eyepieces

Get the most from your small telescope with these fine Multi-Coated eyepieces. Standard .965" barrels fit all Japanese standard small telescopes.

.965" Orthoscopic Eyepieces–
5mm #8580, 7mm #8581
9mm #8582, 12.5mm #8583
$37.95 ea. (2.19)

.965" Kellner Eyepieces
18mm #8584, 25mm #8585

.965" Achromatic Huygenian Eyepieces–40mm #8586
$24.95 ea. (2.11)

Orion® SkyGlow™ Enhanced Light Pollution Filters

Enhance your viewing of faint deep sky objects with the best broadband light pollution filter you can buy. Our SkyGlow absorbs frequencies emitted by city lights, allowing transmission of the rest of the visible spectrum, yielding dramatic results.

SkyGlow Broadband Filters- Photographic and Visual
For use in slight to moderately light polluted areas.

1.25" Broadband Filter–fits 1.25" eyepieces.
#5660 **$59.95** (2.59)

Schmidt-Cassegrain Broadband Filter–fits rear cell of Meade & Celestron SC scopes.
#5658 **$79.95** (2.59)

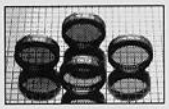
52mm Broadband Filter–For 52mm camera lenses, adapter rings available for other diameters.
#5668 **$66.50** (2.59)

SkyGlow UltraBlock Filters–Visual Only
For severely light polluted areas and faint nebulae.

1.25" UltraBlock Filter–fits 1.25" eyepieces.
#5654 **$79.50** (2.59)

Schmidt-Cassegrain UltraBlock Filter–fits rear cell of Meade & Celestron SC scopes.
#5656 **$99.00** (2.59)

Orion® Color Filters for Eyepieces



Solar system observations are dramatically improved by Orion colored filters. For visual use, thread one into the barrel of any standard eyepiece. For planetary and lunar photography, Schmidt-Cassegrain owners can attach the filter to the eyepiece inside the tele-extender. Can also be threaded directly into a universal camera adapter.

Basic Set of 4 Filters .965"- Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
#5510 **$29.95** (2.19)

Basic Set of 4 Filters 1.25"- Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.
#5514 **$39.95** (2.19)

Expansion Set of 4 Filters 1.25"- Includes #21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.
#5516 **$39.95** (2.19)

Deluxe Set of 8 Filters 1.25"- Includes all the filters in our basic and expansion filter sets.
#5517 **$74.95** (2.79)

Individual 1.25" Filters- #80A Blue (#11040), #58 Green (#5540), #25 Red (#5536), #15 Yellow (#5532), #21 Orange (#5534), #47 Violet (#5538), #11 Light Yellow-Green (#5530), #82A Very Pale Blue (#5544)
$11.95 ea. (.99)

Moon Filters

Cuts 87% of the light from the Moon. Reduces glare by uniformly reducing light transmitted over the entire spectrum.

.965" #5664 **$14.95** (2.11)
1.25" #5662 **$14.95** (2.11)

Breakthrough Low-Price Plössl Eyepieces!

NEW!

These new Multi-Coated Plössl eyepieces are incredibly low priced! Good quality optics for sharp, clear images. Precision four-element Plössl lens elements mounted in sturdy aluminum barrels. Available in 12mm, 18mm, or 25mm focal lengths, with 1.25" barrels. Buy all three for less than some single eyepieces!

12mm-#8596
18mm-#8597
25mm-#8598
$39.95 ea. (2.39)

Deluxe Eyepiece Case

Organize and protect your valuable eyepieces and other accessories. This durable case with double hinges holds up to 10 eyepieces plus barlow. Die cut foam insert for snug secure fit. O.D. 8-1/2"x12-1/2"x3-1/8".

#5913 **$17.95** (2.49)

Deluxe Metal-Clad Accessory Cases

Keep accessories and camera safe and clean. Diced foam inserts can be tailored to your needs. Sturdy handle, two latches, key.

Regular Case: 16"x12"x6½" #5920 **$49.95** (5.09)
Large Case: 19½"x12"x6½" #5921 **$69.95** (5.92)

Deluxe Field Tripod Tote Bag

Designed for the field tripod with padded insert to separate wedge from tripod during transportation. Specifically made for wedge combinations of Schmidt-Cassegrain telescopes up to 10" aperture. Allows storage without changing polar alignment. This blue bag is made of tear, rip and mildew resistant 100% Cordura nylon.

#15096 **$79.95** (4.65)

Orion FlexiShield™ Dew Caps

NEW!

Eliminate dew problems with FlexiShield! Better performance, more rugged, and easier storage than rigid dew caps. Forms into a tube with the velcro closure, opens flat for easy storage and transportation. Fits your telescope tube snugly, with wide rubber padding and full-length velcro closure—needs no screws. Models to fit most telescopes.

90mm Celestron/Meade Spotting Scopes	#4203	**$24.95** (2.39)
90mm Celestron Rubber Armored Spotting Scopes	#4205	**$24.95** (2.39)
4" Meade Schmidt-Cassegrain	#4204	**$24.95** (2.39)
6" Celestron/Meade Schmidt-Cassegrains	#4200	**$39.95** (2.39)
10" Meade Schmidt-Cassegrains	#4201	**$49.95** (2.39)
11" Celestron Schmidt-Cassegrains	#4202	**$59.95** (2.39)

Orion® Dew Zapper

Orion's Dew Zapper is a sure-fire cure for dew problems on your 8" or 10" Celestron or Meade Schmidt-Cassegrain telescope. Dew Zapper gently replaces lost heat, bringing the corrector plate temperature slightly above air temperature.

8" Dew Zappers-fit all Meade & Celestron 8" Schmidt-Cassegrains
DC Model #3503, AC Model #3504 **$39.95** (2.39)

10" Dew Zappers-fit all Meade 10" Schmidt-Cassegrains
DC Model #3506, AC Model #3508 **$39.95** (2.39)

Dew Remover Gun

Moisture that interferes with viewing dissipates quickly with this 12V DC, 156 watt warm air gun. Has 4-1/2' cord.

#5601 **$17.95** (2.48)

Orion® Slow-Motion Adapter

Attaches to your tripod pan head and gives you two slow-motion control knobs to make precision adjustments in altitude and altazimuth. Very handy for tracking planets, the moon, etc. with refractor telelscopes and small spotting scopes. Attaches to any camera tripod with a standard 1/4-20 thread

#7012 **$49.95** (2.59)

Orion® Dual Balance System

Unlike ordinary counter-weights, our system allows instant adjustment in both directions. Easily balances your scope to offset both piggyback loads or rear-cell cameras, 2" diagonals, and other accessories. Rigid, precision machined dovetail bar mounts to telescope in existing accessory holes.

For Meade SC 8" #5150 **$74.95** (4.65)
For Celestron 8" C-8 #5149 **$79.95** (4.65)
For Meade SC 10" #5152 **$84.95** (4.65)

Starlite Red LED Flashlight

The Starlite is the only adjustable-brightness night-vision red flashlight. Lifetime solid-state LED can't burn out. Extra efficient electronic circuit for long battery life. Uses one 9-volt battery (not included)

#5714 **$24.95** (2.11)

Astronomer's Flashlight

Indispensable and indestructible. Has special night-vision red filter and a diffusion lens for even illumination. An essential addition to your astronomy accessories. Requires 2 D-cell batteries (not included).

#5701 **$9.95** (1.89)

Rechargeable Battery Porta-Pack

12 Amp Hour Porta Pac
Ideal for operating your telescope plus higher power-consuming accessories such as an Orion Dew Zapper Battery is encased in high-impact polystyrene. Carrying case of Cordura nylon with shoulder strap and handle. Wt 10 lbs.

#2354 **$99 ea.** (6.23)

Popular Observer's Chairs

Make observing more comfortable and enjoyable with one of these great chairs.

Standard Model-
Has adjustable-height center column and padded vinyl seat. Folds for easy storage.

#5935 **$39.95** (3.96)

Deluxe Model-
Is much heavier-duty, built for professional musicians. Extra thick padding, wide footprint. Adjustable and disassembles for storage.

#5934 **$89.95** (5.65)

Orion® UltraGuider

NEW!

Our newest off-axis guider for Celestron and Meade Schmidt-Cassegrain scopes. Easily adjustable prism allows wider choice of guide stars. Precision helical focuser for your guiding eyepiece. Adjustable camera focal plane position. Suitable for advanced deep-space astrophotography. Compare our price!

#5139 **$119** (2.79)

Standard Off-Axis Guider
Name brand quality at a low Orion price! Our popular, precision anodized guider with fully coated prism.

#5144 **$59.95** (2.59)

Rack & Pinion Focusers

NEW!

These top quality focusers are designed for Newtonian reflectors. Fit any size tubes.

1.25" Focuser
Quality diagonal-cut rack for smooth focusing. Secure slide-fit eyepiece holder. Integral socket for single-stalk diagonal support if desired.

#13017 **$44.95** (2.39)

2" & 1.25" Focuser
Large clear diameter ideal for larger scopes and wide-field optics. Precision diagonal cut rack. Long travel for visual and photographic use. Interchangeable 2" and 1.25" holders with set screws.

#13019 **$69.95** (3.31)

Orion® 45-Degree Erect Image Diagonals

NEW!

See the world as it really is with Orion's new 45-degree erect image diagonal. Upside-down, backwards and topsy-turvy images can often confuse even the stoutest and most experienced observer. Turn it right-side-up with your choice of three models to select from.

.965 Diagonal #8759 **$59.50** (2.59)
1-1/4" Diagonal #8753 **$59.50** (2.59)
Size-Adapting Hybrid Diagonal #8755 **$59.50** (2.59)

Star Diagonals

1.25" Star Diagonal
Primarily for astronomical use, lets you view at a right angle. Multi-coated, for 1.25" eyepieces.

#8763 **$39.95** (2.39)

.965" Star Diagonal
Same as 1.25" Star Diagonal, but with standard coated optics. Works with .965" eyepieces and eyepiece holders.

#8761 **$24.95** (1.89)

2" Star Diagonal

Get the widest possible field of view from your Schmidt-Cassegrain Telescope. This star diagonal features a special aluminized and overcoated precision first-surface flat mirror.

#8767 **$89.95** (2.89)

Orion® Tele-Extenders

For high powered photography with your Meade, Celestron 4", 8", 10", 11", 14" Schmidt-Cassegrain.

Standard Tele-Extender
Use this Tele-Extender in conjunction with an eyepiece. Attaches to visual back of Meade or Celestron Schmidt-Cassegrain telescopes, and to 35mm camera with T-ring, sold separately.

#5125 **$27.95** (1.89)

Variable Tele-Extender
Uses an adjustable extension tube, allowing magnification to be changed without switching eyepieces. Attaches with T-ring, sold separately.

#5127 **$39.95** (1.89)

Universal Camera Adapters

Standard Universal Camera Adapters
Combination Eyepiece Projection Tube and Prime Focus Adapter for refractors and reflectors with 1.25" eyepiece holders. Use with T-Ring (sold separately) to match your 35mm camera.

.965" #5268 **$29.95** (1.89)

1.25" #5264 **$34.95** (2.39)

Variable Power Camera Adapter

Unique sliding barrel design allows variable projection distances during eyepiece projection photography, eliminating the need to change eyepieces when magnification changes are required.

#5262 **$44.95** (2.39)

Orion® T-Adapter

For prime focus photography. Use with T-ring to match your 35mm camera. For Meade, Celestron 4", 8", 10", 11", 14" SC. Can be used as 2" camera adapter.

#5116 **$27.95** (1.89)

VISA

MasterCard

IT'S EASY TO ORDER

- Call Toll-Free and charge to your MasterCard or Visa, or send your personal check to order by mail.
- Shipping & handling charge for UPS Ground or U.S. Mail to lower 48 states only are listed in (parentheses) after each price.
- We ship to U.S. and Canada only.
- California residents add sales tax.

ORION TELESCOPE CENTER

2450 17th Ave., P.O. Box 1158-D
Santa Cruz, CA 95061

AT THE EYEPIECE

Dear Reader,

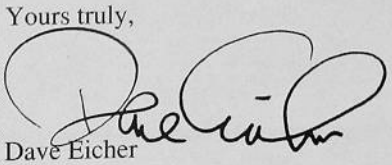
Welcome to another season of warm observing weather in the Northern Hemisphere. Now that I've displayed a northern bias, I'll tell you that our lead story in this issue focuses on the Southern Milky Way. After independent trips below the equator by authors Tom Polakis and Brian Skiff, the two decided to join together to describe the visual splendor of the Southern sky. We hope you'll like what they have to say, even if you are a northerner.

Other feature articles this time take you on a journey to observe the little-known globulars of Sagittarius. If you've observed M22, M55, M69, M70, and all of the other bright globulars, let Bob Bunge show you the really interesting globs in this rich region of sky.

Astrophotographer Chris Schur's superb mosaic of nebulosity in central Cygnus forms the backbone of his story on extremely faint nebulae in that region. Whether you observe or photograph (or both!), Chris' sharp descriptions and computer-generated charts will zero you in on this fascinating group of deep-sky objects.

We're also proud to offer Todd Hansen's story on observing quasars and BL Lacertae objects. Todd has compiled an extensive list of each of these types of objects and offers it along with superb tips on observing them. Along with our regular features, we also offer a second Australian sketch book by the talented artist Gerd Bahr-Vollrath. His drawings are certainly an inspiration.

Yours truly,



Dave Eicher
Editor

Here Come the Women...

Dear Mr. Eicher / I was so glad to see an article in the current issue on the presence of women at the Texas Star Party. Lord knows that the participation of women in such things is a sorely neglected topic in journalism today and, despite the fact that *Deep Sky* is supposed to be about amateur astronomy, why not have it here? I mean, what else could have gone onto those two pages?

I do wonder about the propriety of a social movement that entails a "de-education," if you will. Witness the disappearance of the nonspecific (and grammatically correct) "he" from magazines such as yours. I have to keep reminding myself: this is all pro-women, and not anti-men. (And by the way, what did happen to the nonspecific "man"?)

By the way, in the unlikely event that my wife's name ever comes up in *Deep Sky*, she is Mrs. Rachut, and not "Rachut," as is the journalistic fad. — *Eric Rachut, 1404 2nd Street S.W., Austin, Minnesota 55912*

Going Deep for Nebulae

Dear Dave / Enclosed is a selection of my latest attempts at photographing some pretty unusual nebulae. It's hard to believe it has been two months since I sent some photos, but at least I had some good weather for photography and something to show for it.

I spent a lot of time working on the faint supernova remnant S147 in Taurus. It's a tough one. The enclosed photo is a 90-minute exposure shot with a 500mm lens at f/2.8. I made a three-hour exposure, but the negative is so dense it's impossible to get a good print with standard burning and dodging. I then made two 90-minute exposures, but trying to align them is nearly impossible and they are as hard to print as a single three-hour exposure anyway. So the print I sent is a compromise, but it still shows a great deal of the nebulosity.

I also enjoyed making a pretty satisfactory photo of the Pelican Nebula in Cygnus and the extremely faint planetary Jones 1, featured a couple of issues ago. The Jones 1 print is a sandwich made from two negatives. I hope you enjoy the photos. — *Chuck Vaughn, 4387 Othello Drive, Fremont, California 94555*

Observing the M31 Globulars

Dear Dave / Having just gotten started delving into an observing list obtained from Brian Skiff's article "All About M31" (*Deep Sky* #8), I appreciated the timely arrival of David Higgins' article "The M31 Globular Cluster System" (Autumn 1990 issue). Although I'd taken a rather cursory look at M31's brightest associations and clusters, this article motivated me to make observations of some of the Andromeda Galaxy's many globulars.

It was quite surprising to find that not only were many of these globulars quite easily visible in my 13-inch scope, but they also revealed information about their sizes and degrees of concentration, especially when viewed at high magnifications.

As M31 passes near the zenith for most of the North American continent, it can be observed for several hours during the autumn with very little in the way of atmospheric extinction or turbulence. The following observations were made from a dark site near Phoenix with the 13-inch scope, typically operating at 312x. Keep in mind that "bright" is used here as a relative term!

The following objects appeared in Mr. Higgins' article.

G73: Just nonstellar, held steady at low magnifications such as 115x, 2" in diameter with a sharp peak in brightness at the center, 7' away from NGC 205, with which it is associated.

G78: This is the object most recognizable as a globular out of the whole batch. It shows a bright stellar center with a surrounding sharp-edged glow.

G213: This object is moderately bright, much brighter at its center, and has a faint, surrounding glow; it lies 4' away from G233.

G233: Extremely faint, has a very low surface brightness, uniform in brightness, but occasionally there are hints of a central brightening. G213 is a mere 4' away.

G226: A very low surface brightness object, faint, shows a 3" uniform disk, resembles a faint planetary nebula.

G244: Extremely faint, uniform, smaller than G226, which lies in the same high-power field.

G279: Similar in appearance to a very faint planetary; a tiny, gray disk that disappears during periods of poor seeing.

A mini-portfolio by Chuck Vaughn: The Pelican Nebula and western portion of the North America Nebula photographed with a 500mm f/4 lens, hypered Tech Pan film, and a 120-minute exposure with an H-alpha filter.

Above left: Supernova remnant Simeis 147 in Taurus photographed with a 350mm f/2.8 lens, hypered Tech Pan film, and a 90-minute exposure with an H-alpha filter.

Left: Planetary nebula Jones 1 photographed with a 14-inch f/11 SCT, hypered Tech Pan film, and a composite made with two 50-minute exposures sandwiched in the darkroom.

The following objects were not included in the Higgins article:

G76: Pretty bright, barely nonstellar, bright in the middle with a sharp-edged disk.

G280: Pretty bright, nearly stellar, occasionally shows hints of a surrounding faint glow; this object shows an interesting contrast with the open cluster C 410, just 2' away.

G295: This is the brightest of all M31 globulars, but is completely stellar, showing no sign of a disk.

G302: Pretty faint, uniform, with a sharp-edged disk; comparison star of the same magnitude lies 1' away.

These observations simply skim the surface of the wealth of detail that exists within M31. I look forward to viewing a dozen or so open clusters and associations within the Andromeda Galaxy. — *Tom Polakis, 223 East Hermosa Drive, Tempe, Arizona 85282*

Dear Dave / Some time ago I prepared an observing list of the brightest globular clusters in M31. Thus, when I saw David Higgins' article I thought I might compare his list with mine. This comparison yielded several interesting results.

First, even though we had utilized similar sources for our lists, only five of the 22 globular clusters I had catalogued appeared in Mr. Higgins' list. Indeed, I was somewhat disappointed to find absent from David's list what I have considered to be the most conspicuous of M31's globular clusters, G76 (Hubble-Baade 12). Note that this object is depicted near the bottom center on chart 24 (page 26) in David's article. Of course I realize it is difficult to create a satisfying, complete, yet manageable list for the pages of a magazine. (A list containing 500 objects is pretty unwieldy!)

This brings to light a second point: How many of these objects are visible in amateur telescopes? Unfortunately, David's article suggests that unless the reader has access to a large telescope, the search for these globulars is futile. From experience I can state that this is wrong. With a 12.5-inch f/4.8 Newtonian at 204x I observed 16 of these, and at no time did I require averted vision. Only fatigue and a wish to explore the Perseus cluster of galaxies kept me from seeing more of them. I am convinced that 25 or more of these globulars are visible in a 12.5-inch scope if one is willing to put forth the time and effort. Moreover, in 1981 Walter Scott Houston reported that Thomas Wilson had observed 15 of M31's globular

clusters with a homemade 12.5-inch scope, and had observed as many as 10 of them in an 8-inch scope. Amateur astronomers with telescopes smaller than 16 inches or 12.5 inches shouldn't be scared of trying to see some of these fascinating objects.

In addition to Paul Hodge's excellent book *Atlas of the Andromeda Galaxy*, good charts can also be found in the following articles: Hubble, *Astrophysical Journal* **76:**44 (1932); Sargent *et al., Astronomical Journal* **82:**947 (1977); and Battistini *et al., Astronomy & Astrophysics* **42:**357 (1980). — *Dave Kratz, Code 913, Goddard Space Flight Center, Greenbelt, Maryland 20771*

Dear Dave / Congratulations on the Autumn 1990 issue, which I think is one of the best ever. All three main articles offered a deep-sky observer's dream, especially the one on the M31 globulars. The first time out hunting for them I found six in half an hour with my 25-inch Dobsonian. It was fun and exciting and made me feel like I did 20 years ago when I had my first views through a telescope.

However, someone blew it with the finder chart for Pease 1 in M15. There is no way I can find the field, because all the stars on the chart are nearly the same magnitude. I know I could pull Pease 1 out of the field if I could only get a good finder chart! — *Dave Kriege, 923 Stoney Road, Lake Mills, Wisconsin 53551*

Those Confused Double Stars

Dear Dave / Just a quick note to point out a slight error in the Autumn 1990 issue. In Brian Skiff's excellent column on double stars in that issue, he misidentified ADS 16836 as 52 Pegasi, rather than its correct identification of 72 Pegasi. — *Mike Porcellino, P.O. Box 388931, Chicago, Illinois 60638*

Evaluating Nebular Filters

Dear Dave / I have been using Lumicon's nebular filters with my 10-inch Newtonian for about four years now, and I have a good understanding of just what looks good in which filter. I appreciate the fact that *Deep Sky* finally got around to presenting some sort of review of the various filters available for the amateur, but the article in the Autumn 1990 issue had a number of problems.

First, the UHC and O III filters are nebular filters, not LPRs. They are designed for only emission nebulae and are not at all intended for use on anything else — something Jack Marling even states in his technical information. To rate them on galaxies and clusters, as Dan Sheber's group did, is a little ridiculous, because the spectra from these objects is essentially continuous. The nebular filters would block most of the light from these objects — especially the O III, with its narrow (11 nm) passband centered on the oxygen III lines at 495.9 nm and 500.7 nm. In the article the filters were tested only on a limited number and variety of nebulae, thus biasing the results. A number of the statements made in the article were poorly worded and sometimes downright wrong. The article gave the impression that the UHC and O III filters yielded marginal performance, when in fact they are probably the most useful filters to have in your observing kit. As far as clusters and nebulae go, I've found that using either no filter or, occasionally, Lumicon's Deep-Sky filter works best. The Deep-Sky filter is the only one that can be considered an all-around LPR filter, because it blocks emission lines of mercury and sodium vapor lamps, and transmits almost everything else.

Second, unlike Mr. Sheber, I have found that all the Lumicon filters perform best under relatively dark skies. They block natural airglow and the faint glow of unresolved stars. They greatly enhance most emission nebulae and at times make a 6-inch scope show the Veil, North America, Helical, or Dumbbell nebulae as well as a 12-inch does without a filter. For overall nebular performance, the UHC may be better than the O III, but for some specific nebulae both bright and dim, the O III will outperform the UHC. In fact, the O III is the filter of choice when it comes to hunting planetary nebulae.

I found a variety of peculiar statements in Mr. Sheber's article. For example, he stated the Trifid Nebula did not appear very impressive in the O III filter. This is because the Trifid's light is a blend of various wavelengths of emission and reflection nebulosity. Reflection nebulae are hurt by these filters, and thus observers need to employ a filter with a broader passband (not "lower contrast"!). The O III shows much more detail and outlying nebulosity in M17 and M8 than any other filter I've tried, and it is definitely not the "borderline performer" Sheber says it is. It made the extremely faint Cygnus Bubble, NGC 6888, an easy target, revealing it as an oval ring with detail visible on one end. It also makes the Helical Nebula stand out much better than with the UHC or Deep-Sky filters, although any of the filters improves the view relative to no filter at all. The O III filter has revealed a few large nebulae so faint they are not plotted in *Uranometria 2000.0*, such as a large

one I call "the fingers," located just southeast of NGC 7510. I have even seen the eastern arc of the Veil Nebula when a Full Moon was in the sky!

As for the H-Beta filter, I've found it useful only for four objects: the California Nebula, the Horsehead Nebula, the Cocoon Nebula, and M43. It hurts practically everything else. The Swan Band filter cannot really be considered an LPR filter for anything except comets. The O III filter is best used on most planetaries and many emission nebulae. Contrary to the table on page 23 of the Autumn issue, the UHC filter performs very well on faint emission nebulae. The article by Mr. Sheber and friends simply didn't do the Lumicon filters justice. — *David Knisely, Observing Chairman, Prairie Astronomy Club, 1616 North 14th Street, Beatrice, Nebraska 68310*

Dear Dave / I wanted to express my appreciation for the excellent article on nebular filters. It saved me from making a costly mistake — I had planned to purchase the H-Beta filter from Lumi-

The peculiar galaxy NGC 520 photographed by James R. Foster with an 11-inch f/10 SCT, hypered Tech Pan film, and a 200-minute exposure.

con for my reflector to observe faint nebulae. Thanks to your survey, I am now able to make a more prudent choice. Thank you very much for your help. — *Eric F. Diaz, 2141 Gunderson, Apt. 308, Berwyn, Illinois 60402*

Ernie Ostuno's Galaxy Challenge

Dear Dave / I wish to commend you and Ernie Ostuno for the fine challenge you have given us with some difficult-to-find galaxies in Equuleus, as reported in the Autumn 1990 issue. With my trusty 11-inch SCT, recent superb skies, and the help of Ernie's finder charts, I was able to observe all of them with the exception of II Zwicky 123.

I found an error, though. In the text Zwicky 401.006 is mentioned as being southeast of NGC 7040, and it is actually southwest of the bright galaxy, as shown of course on the chart. Unfortunately on the chart it is erroneously labelled Zwicky 401.086. Nevertheless, some sleuthing brought it into view and solved the mystery. And some diligent searching in the *Master List of Nonstellar Astronomical Objects* correctly identified it as Zwicky 401.006.

I had great fun when it came time to plot my drawings, by searching through the *Master List* and converting the equinox 1950 coordinates to equinox 2000. With this method I have located the field of II Zwicky 123 and will have to try that one, though Ernie's negative sighting doesn't leave me much hope. Keep up the good work. I anxiously await the next issue. — *Lucian J. Kemble, Box 220, Lumsden, Saskatchewan, Canada S0G 3C0*

Shooting the Strange Ones

Dear Dave / Hello again. I've been busy shooting more faint galaxies and have enclosed a selection of prints for your perusal. One of the photos is a shot of NGC 520, a peculiar galaxy in Pisces, made with my 11-inch f/10 SCT, hypered Tech Pan film, and a 200-minute exposure. It shows the structure in this odd galaxy quite well, and to me it appears to be shaped like the flower of a Yellow Honeysuckle plant or like a young orchid. NGC 520 seems to be spewing luminous matter in wing-like extensions; the larger projection seems to be oriented toward us, while the smaller, forked projection seems to be pointed away from us. Note the curious looping, irregular material around the center of this system. What's going on with this galaxy? Are the structures in NGC 520 caused by gravitational interactions between two galaxies? Are magnetic or electromagnetic forces caused by a supermassive black hole to blame? If your readers have any information on this system, I would appreciate hearing from them. — *James R. Foster, 1335 North Poinsettia Place, Apt. 4, Hollywood, California 90046*

Deep Sky *welcomes letters to the editor on articles, article suggestions, criticisms, observing or astrophotography reports, or simply things that concern you as an amateur astronomer. Address all letters to: Dave Eicher, 21027 Crossroads Circle, Waukesha, Wisconsin 53187.*

To See The **Southern Cross**

Allow your eyes alone to explore the beauty and granduer of the Southern Milky Way, which is completely unrivalled by the North!

by Tom Polakis and Brian A. Skiff

"When you see the Southern Cross for the first time, you understand now why you came this way." So the song goes, written by Stephen Stills and vicariously enjoyed by amateur astronomers for years. The song is especially memorable for anyone who has been to the Southern Hemisphere to see the Southern Milky Way. Despite being fanatic deep-sky observers, the authors feel it's nice to spend time just looking at the broad vista of the sky.

The two of us made visits to Australia (TP) and Chile (BS) last year primarily to do deep-sky viewing. Having brought telescopes and massive observing lists, we expected to be glued to the telescope, shuttling between atlas and eyepiece during clear nights. But the remarkable panorama of the southern sky distracted us for longer and longer periods each night — not surprising considering the center of the Galaxy passes straight overhead! Here, then, are some visual impressions of the Southern Milky Way from dusk to dawn on a June evening.

At the end of evening twilight, the sidereal time is about 12 hours. This is when, for northern hemisphere viewers, the Milky Way encircles the horizon. You are effectively standing on the plane of the Galaxy looking out toward the Virgo Supercluster of galaxies spanning from Ursa Major in the north down to Hydra and Centaurus near the southern horizon. Down Under, however, the Milky Way predominates, from Puppis setting in the west across to the rising constellation of Sagittarius. At a glance, the entire portion of the Milky Way unknown to northern observers is filled in. Working eastward below Canis Major and Puppis, the far southern constellations Vela, Carina, Crux, Musca, Centaurus, Triangulum Australe, Circinus, Ara, Lupus, and Norma are revealed. Then it's back to old familiar Scorpius.

The collection of bright stars familiar to northerners that outlines Orion and Canis Major is the beginning of a wide band of zero-to-third magnitude stars spanning from Orion to the head of Scorpius. The band lies at a small angle to the galactic plane, starting west of the plane in the north, crossing in Carina, then re-emerging north of the plane in Centaurus and Lupus. As conspicuous as the stars of Orion and Canis Major, the stars increase in density progressing east and south. The area of bright stars visible along the southern horizon on northern June evenings is its east end. So many bright stars render the southern Milky Way constellation patterns a formless jumble, just a lot of stars. The comforting star patterns are replaced, however, by gross features of the Milky Way that serve as visual guideposts around the sky.

The Milky Way through Vela is similar to that in Puppis we northerners see on winter evenings. It is pretty uniformly bright but has a grainy texture, resulting from hundreds of marginal naked-eye stars that can seem to lie behind the bright belt of stars just mentioned. Vela's dark dust lanes are broad and subtle, and it lacks intense star clouds. In all, Puppis and Vela are similar in appearance to Cepheus and Cassiopeia, which lie at a similar location opposite the galactic anticenter in Auriga. This is not the first bit of symmetry we'll see.

Spanning the Vela-Carina border is a relatively conspicuous asterism known as the False Cross. It consists of Kappa Velorum at the head, Delta Velorum and Iota Carinae as the arms, and Epsilon Carinae at the foot. It is not quite as well formed nor so well isolated as Crux, the traditional Southern Cross. One look at a naked-eye star chart will show that the False Cross is so buried in the clutter of bright stars that one professional astronomer asked when it was pointed out, "Which cross? There's three or four of 'em!" Once you've got it, though, it's hard to miss. A distinctive feature is two naked-eye open clusters off the western arm and the foot: IC 2391 (centered on fourth-magnitude Omicron Velorum) and NGC 2516, which visually resembles Messier 7.

The Milky Way picks up again considerably in Carina, especially the region around the bright nebula centered on Eta Carinae (NGC 3372), which is the very brightest spot in the Milky Way. Use of a sky-suppressing nebula filter, even from a dark site, brings out the large Eta Carinae nebula dramatically. This nebula appears about 3° in diameter and is flanked by three easy naked-eye open clusters, including NGC 3114 on the west and NGC 3532 just east of the nebula. The third cluster, IC 2602 on the south, surrounds Theta Carinae and is often called the "Southern Pleiades." But here the north wins for once: because it is smaller and has fewer naked-eye stars, it is not really a match for the real thing. Even so, it is still an excellent binocular object.

This takes us into Crux, sitting 60° above the horizon when on the meridian. Alpha and Beta Crucis are intense, white zero-magnitude stars, that incidentally point right at Omega Centauri only half a handspan-at-arm's-length northeast. When a northerner explains how the globular is found by star-hopping down from Spica, miles to the north, native southern hemisphere observers laugh in derision!

The famous Coalsack is highlighted by Alpha Crucis on its western edge and by a star cloud to the east. It appears about 5° across and irregularly round, slightly tapering to the south. One sixth-magnitude star is easy to see against the darkness near the center, and several others occasionally come into view. Using averted vision from a dark site, the Coalsack shows three subtly brighter striations crossing it

The beauty of the Southern Milky Way is fully apparent in these photographs by Phil Dahl of Mesa, Arizona. Taken from Kenilworth, Queensland, they show the "main line" bright and dark features of the Milky Way (above) and the rgion of the Eta Carinae Nebula (left). The photos were made with a 28mm f/4 lens, Agfachrome 1000 film, and exposures of 11 minutes each.

This artwork from A. Pannekoek's masterful volume on the Southern Milky Way shows the region of Vela and Centaurus.

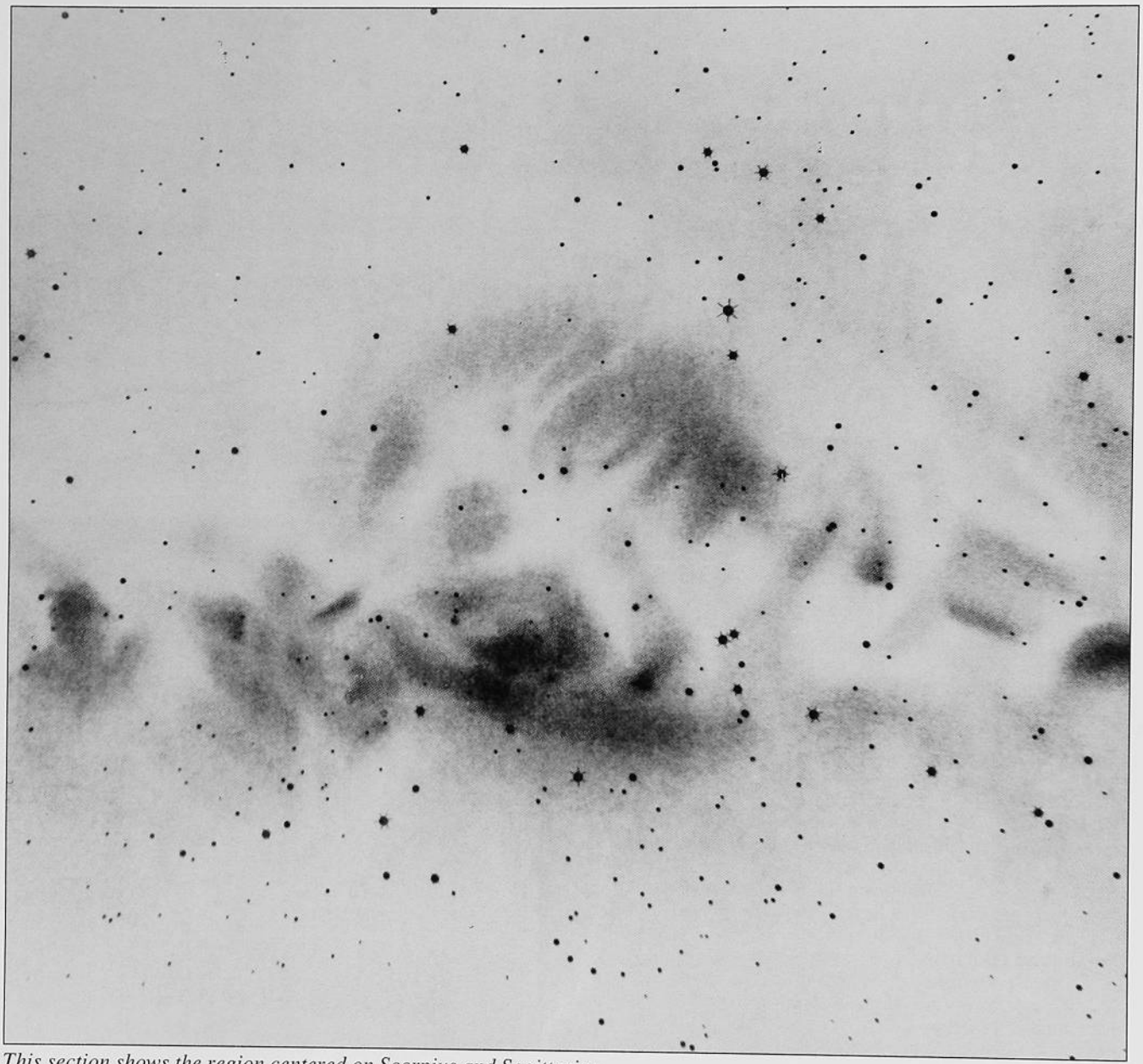
from east to west.

The Coalsack is the head of "th e Emu" for Australian observers. This aboriginal "constellation" can be considered the largest in the sky, representing the ostrich-like animal indigenous to the Australian continent. The emu's "neck" is a dark lane 5° wide extending through Lupus and Norma west to Alpha Centauri, never really reaching the Coalsack "head." The main body is formed by dark clouds in Scorpius and Sagittarius; the tiny legs are the dark lanes in Ophiuchus.

Crux, together with Alpha and Beta Centauri — four zero- and first-magnitude stars among them — are as beautiful and prominent as the Big Dipper or Cassiopeia in the north. The four bright stars really stood out for us, even from downtown Brisbane, Australia and Santiago, Chile. They form the only really prominent star pattern near the south celestial pole.

As the galactic center gains altitude during the evening, a feature rarely seen in published photos comes into view. A thin strip of Milky Way glow arcs over the central bulge of the Galaxy. It peels off the main band near Alpha and Beta Centauri (above the neck of the Emu), extends way north outward from the plane into northern Lupus, passes through the stars in the head of Scorpius, then moves back toward the plane in Ophiuchus. There it joins with the "thumb" of the Milky Way, merging with the band of light west of the Great Rift below the western wingtip of Aquila. This last part was familiar to us from dark sites in the north, but our surprise came in seeing that this feature doesn't rejoin the Milky Way until it reaches Centaurus, almost 90° away! This band makes the central bulge at least 45° wide. Its center is no longer near the Sagittarius star cloud, as we're familiar with from the north. Rather, it is up by the handle of the dark "Pipe Nebula" on the Scorpius-Ophiuchus border, close to the true center of the Galaxy.

At midnight the center of the Milky Way is on the meridian — not down in the dirt, but at the zenith. The telescope field basks in an eerie, diffuse glow cast by the Galaxy's center. Cygnus doesn't cast a shadow. The large Sagittarius star cloud appears about 5° by 3° in size, with its major axis oriented northeast to southwest. Its northwest edge comes to an abrupt halt at the Great Rift, while the cloud blends in



This section shows the region centered on Scorpius and Sagittarius.

smoothly to the southeast with the faint, uniform glow that fills the entire Teapot. Surprisingly, this brightest starcloud in the Milky Way is relatively featureless in it brightest portion, as though it were "overexposed" and too bright to show any internal structure.

By this time the Scutum star cloud is at about the same elevation as the Norma Star cloud. They are remarkably similar, symmetrically placed with respect to the center and with naked-eye clusters at their hearts (Messier 11 and NGC 6067, arguably the two best open clusters in the entire sky). The Norma star cloud is of high surface brightness and outlined by the neck of the Emu to the west and another dark obscuring cloud on the north. (The Great Rift and another dark cloud do the job for the Scutum star cloud.) It's frustrating that this overlooked constellation rises only a few degrees above the horizon, even from southern Arizona deserts.

By 2 a.m. the familiar northern Milky Way in Aquila and Cygnus has reached the meridian, the latter being pretty low in the north, much as Sagittarius is low in the south for northerners. But as the brilliant southern Milky Way loses elevation, up comes the Small Magellanic Cloud, another storehouse of telescopic delights. Just before morning twilight on this long austral winter night, as the galactic center is still a few hours from setting, both Clouds are up along with groups of galaxies in the star-poor constellations around Pavo, Grus, and Fornax.

If there were a few more hours of darkness, we'd again be standing on the galactic plane, as northern observers were doing twelve hours earlier, but this time looking out toward the south galactic pole past the nearby Sculptor group of galaxies. Missing from the picture would be Perseus, Cassiopeia, and Cepheus. But we'd gladly trade these three for any one between Vela and Norma.

Tom Polakis is an avid deep-sky observer and talented artist living in Tempe, Arizona. Brian Skiff is an astronomer at Lowell Observatory and coauthor of the book Observing Handbook and Catalogue of Deep-Sky Objects *(Cambridge, 1990).*

Exploring the Cygnus Nebulosity Complex

Look deep into one of the prettiest regions of nebulosity in the sky.

by Chris Schur

Springtime is my favorite time of year. With the return of warm weather also comes the return of the summer Milky Way in the late evening sky. No region typifies what deep-sky observing is all about better than that gem of the summer Milky Way, the richly-studded constellation Cygnus. Scattered over a major portion of Cygnus lies a huge complex of emission nebulosity and supernova remnants. With the proper combination of eye, filters, and film, it's possible to uncover an incredible amount of nebular detail spread over the constellation.

While Cygnus is home to a gathering of bright, well known deep-sky treasures, there remains a large number of less familiar objects that are seldom visited by amateur stargazers. Normal piggyback wide angle photographs of the Cygnus Milky Way reveal dozens of individual ruddy gas clouds mixed with thousands of stars, and a bulging dust lane running along the length of the Cygnus swan.

Outfitting for Success

To capture these objects well enough to study, it's necessary to greatly increase the contrast between the sky background and faint nebulae. Even the darkest observing sites on Earth aren't dark enough to help much with this. What is required is a fine grain, high contrast and very red sensitive film, in combination with a glass or gelatin filter to isolate the predominantly red hydrogen-alpha light emitted by these objects.

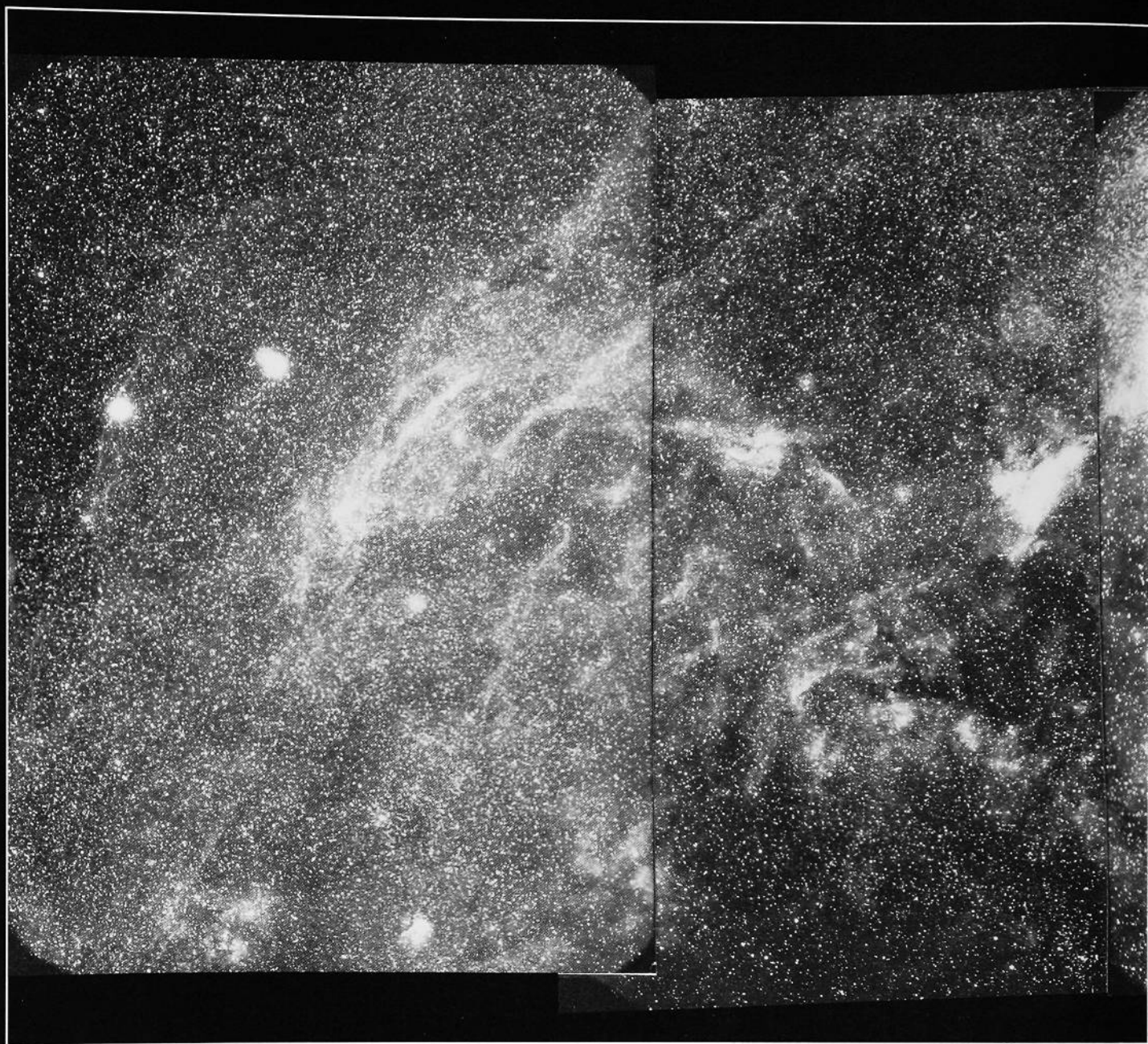
Over the past decade, film technology and colored filters have been developed especially for this task. The leading film for hydrogen-alpha work, Technical Pan 2415, was developed by Kodak for solar photography for research on flares and other red light solar phenomenon. It wasn't long before astrophotographers found that this inherently slow emulsion could be successfully gas hypersensitized in a mixture of 92 percent nitrogen and 8 percent hydrogen to achieve dramatic speed increases. The film retains its red sensitivity when hypered, and when combined with the correct optical filter, is the most powerful film/filter combination available today for skyshooting emission nebulae.

The best filters to use are the deep red Wratten #25, #29 or preferably, the nearly infrared Wratten #92. If you want to use a glass filter, the Lumicon H-alpha pass filter is the best choice. It strongly resembles the Wratten #92 in spectral response but transmits a slightly greater percentage of red wavelengths due to enhanced coatings and dyes.

The best lenses for red light astrophotography are those that are fast, and have at least an inch of aperture. Probably an 50mm f/2 lens is suitable, but to get a reasonable image scale and resolution on the smaller objects, a 135mm f/2.8

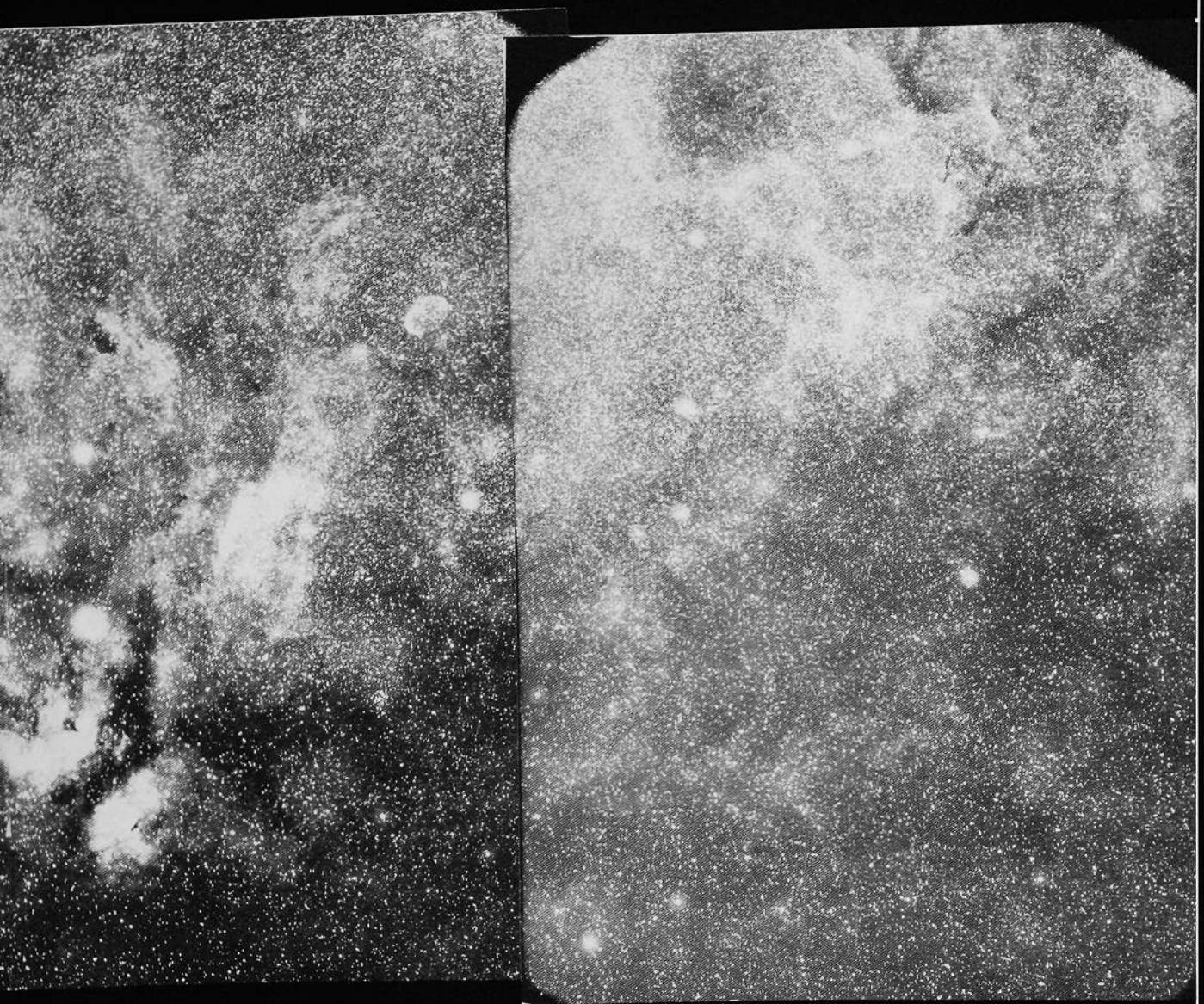
Martin C. Germano's spectacular image shows a portion of the nebulosity comprising IC 1318 near the bright star Gamma Cygni. The bright open cluster NGC 6910 lies at lower left. Germano used an 8-inch f/5 reflector, hypered Tech Pan film, and a 45-minute exposure.

Above: IC 1318A is a triangular nebulosity visible in small scopes at low powers. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 45-minute exposure).

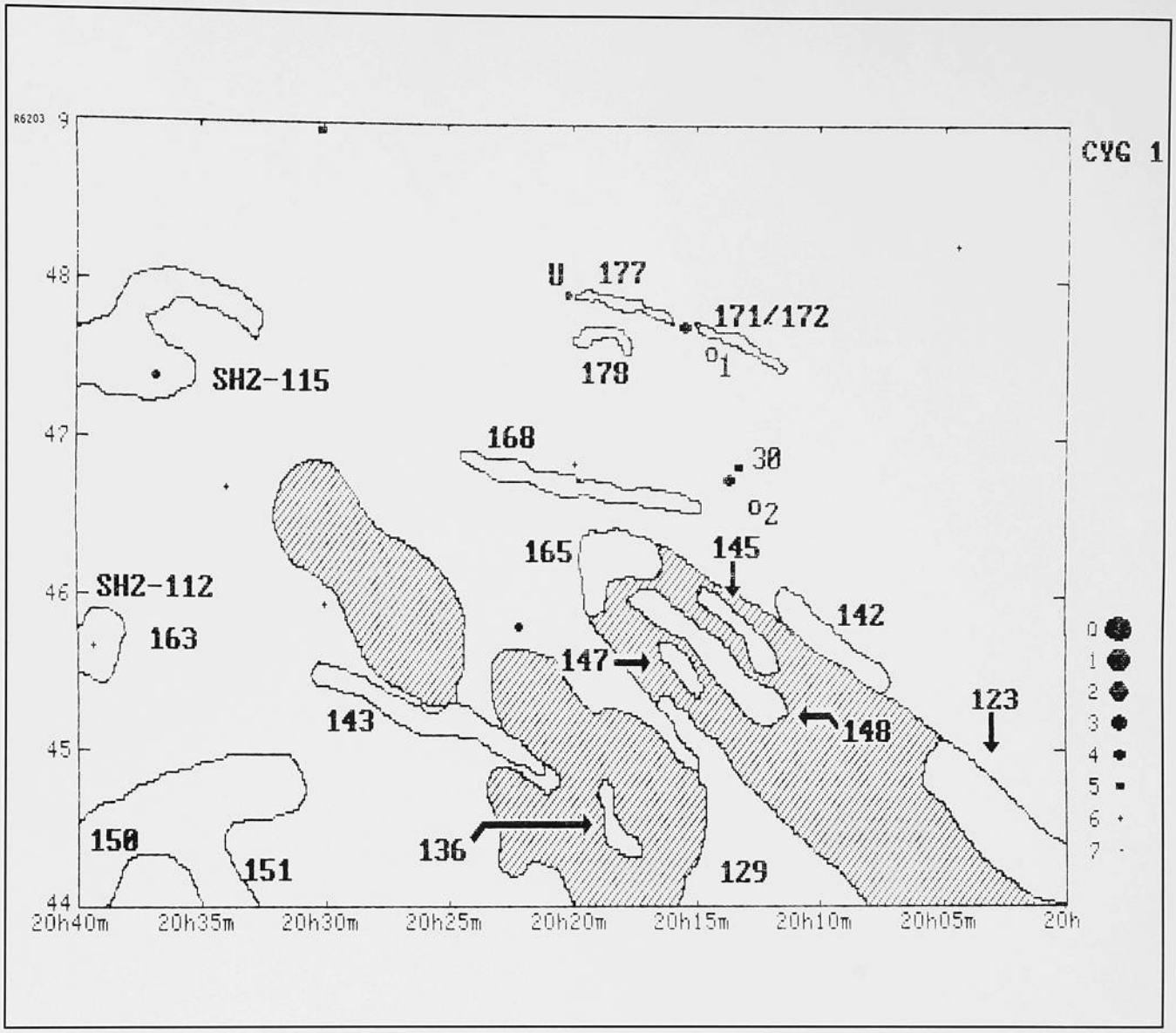


The Cygnus Nebu

In a single photomosaic, astrophotographer Chris Schur has captured a great swath of nebulosity surrounding the bright star Gamma Cygni. Made from four panels, each a deep, red-filtered exposure made with an 8-inch f/1.5 Schmidt camera and hypered Tech Pan film, the mosaic shows many features of central Cygnus. Panel one contains the bright stars Omicron[1] and Omicron[2] Cygni and nebulae Sharpless 2-115 and Sharpless 2-112. Panel two contains the bright nebula IC 1318A and dark nebula NGC 6914, as well as many other smaller nebulae. Panel three contains Gamma Cygni itself, surrounded by IC 1311, IC 1318, open cluster NGC 6910, and the supernova remnant NGC 6888. Panel four contains a smattering of bright stars and the large, faint nebulae Sharpless 106 and Sharpless 109.



ar Complex



CYGNUS PANEL ONE

lens is a good choice. I use an 8-inch f/1.5 Schmidt camera for the highest resolution in small areas of the sky.

Because all lenses are calibrated to focus for white light, you'll have to do a focus test with the red filter installed to be certain you're focused at infinity. To do this, take a series of exposures — star trails work fine — with the lens set at different settings ranging from infinity to the infrared focus mark, in four or five steps. Examine the results carefully with a magnifier and select the best setting for the sharpest images. Once the lens is adjusted for the proper focus for use with the red filter, you are ready to explore the Milky Way in a whole new light.

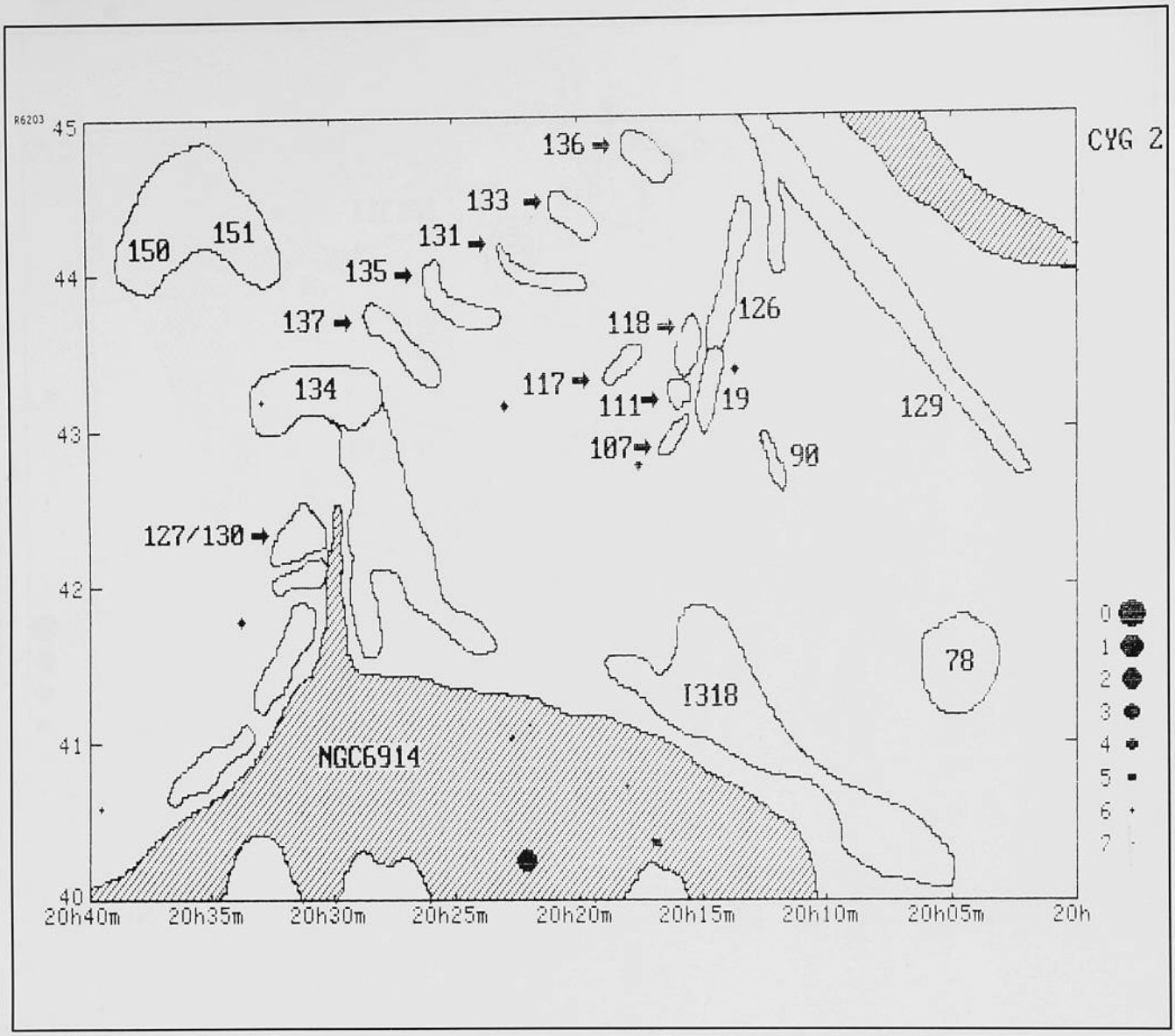
Generally, exposure times should be longer than white light shots. Thirty minutes to an hour at f/2.8 is typical with a Wratten #92 filter, but the higher transmission and broader bandwidth Wratten #25 requires only 15- to 30-minute exposures. In general, the darker the filter, the narrower the bandwidth, and the higher the contrast between sky and nebula on the film. You will have to experiment with the film/filter combination that best suits your needs.

Exploring the Cygnus Region

By inspecting the photo you'll see several key fields to explore, including the Gamma Cygni area, the field surrounding 52 Cygni, the area east of Deneb, and the region near Omicron Cygni.

Centered around the star Gamma Cygni is the thickest nebulous region in the entire sky. It is also one of the most interesting, especially with the recent advent of gamma-ray and ultraviolet satellite observations. For example, in 1979 an extensive region of hot gases was discovered in this area and was identified as a supercomplex of wispy nebulosity over 1,000 light-years in diameter. It is now known that this collection of interstellar matter is the largest of its type in the entire Galaxy. Primarily studied by x-ray observations on board orbiting satellites, the interstellar medium in this part of the sky contains huge volumes of gas heated above 1,000,000° by shock waves from ancient supernova explosions.

In hydrogen-alpha light, long, stringy gaseous filaments can be seen here, of the type normally associated with powerful shock waves propagating through the interstellar medium. Careful analysis has revealed that the filaments correspond well with regions of high x-ray emission. The calculated mass of the entire complex comes in at several million suns. With a diameter of 1,300 light years, and a distance of about



CYGNUS PANEL TWO

6,000 light years, the immensity of this bubble of gas is stunning. A similar gas bubble lies in Orion, but Orion's bubble is a mere half the size of the Cygnus bubble. The accompanying photos give some idea of the staggering complexity of this feature — a tangle of dust, hot excited gasses, and countless thousands of stars.

In the accompanying series of charts, the letter "S" followed by a number is the Sharpless nebulosity catalog number, and separate NGC objects are labeled accordingly. Individual numbers without a prefix correspond to the catalog of the German astronomers Dickel, Wendker, and Bieritz.

The Cygnus One Chart

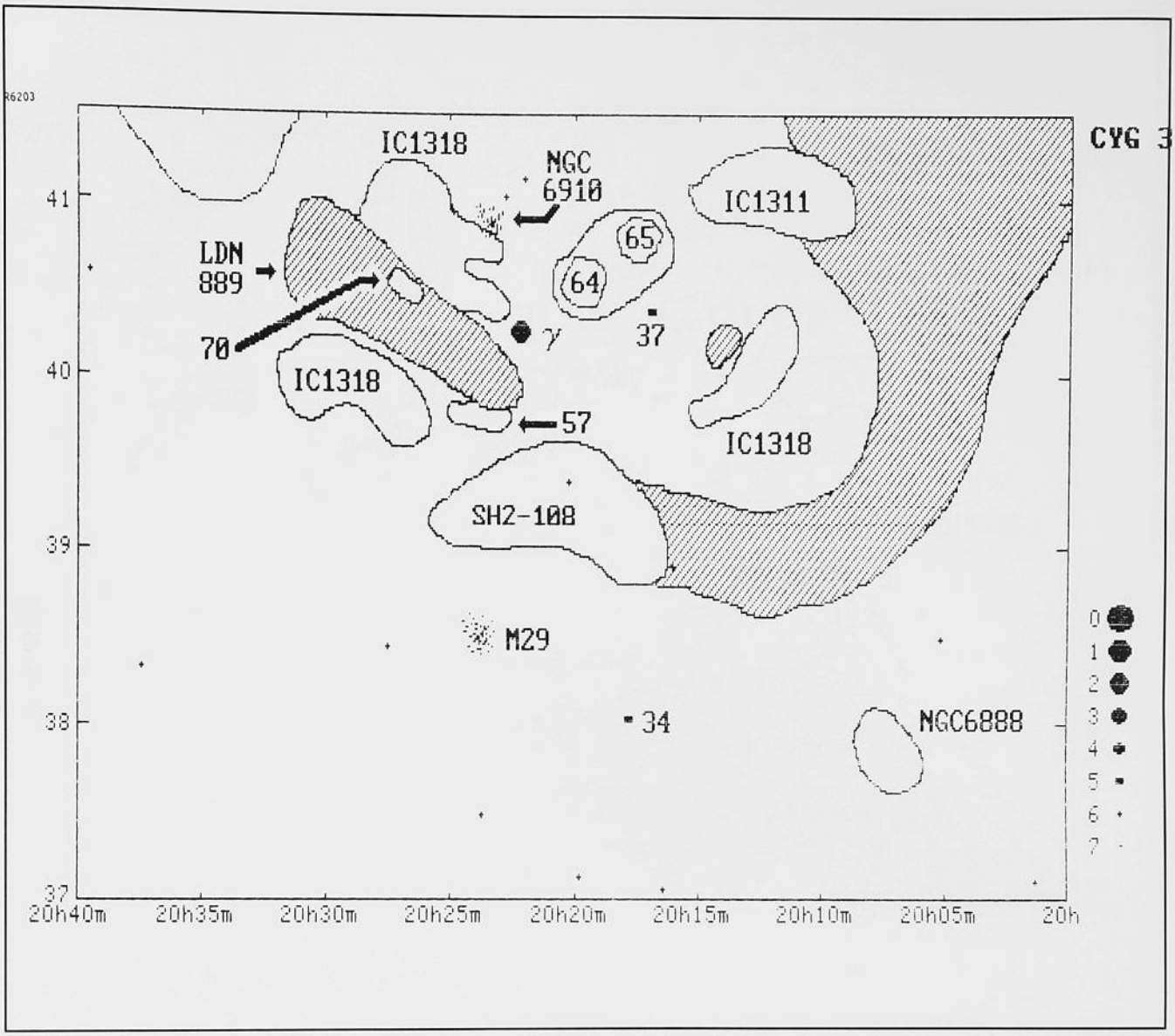
This region is dominated by a series of huge arcs that forms the northern end of the gas bubble complex. The key stars are Omicron[1] and Omicron[2] Cygni, each visible with the naked eye. **DWB 165**, **DWB 148**, and **DWB 129** form the main brightest portions of the ridges of supernova shock wave fronts, with numerous dark lanes of dust obscuring the southern end. Dozens of fainter arcs cover the region, and many are curved in the same direction, supporting the theory of a common origin. **Sharpless 2-112**, also known as DWB 163, is one of the brightest objects in the field. It can be glimpsed in amateur scopes with a good nebular filter.

The Cygnus Two Chart

Continuing southward, we find one of the most spectacular fields of emission nebulae in the Galaxy. The southern end of the huge bubbles of gas in field 1 are continued in the top of the frame, dominated by DWB 129 and the bright filament that encompass **DWB 126** and **DWB 19**. DWB 19/111 was visible in a 13.1-inch scope fitted with a nebular filter as a knot of nebulosity. The entire field appears to be glowing. The dark nebula **NGC 6914** dominates the southern end of the frame, its huge pyramidal shape blocking out both luminous gas and stars. Skirting its edges lies the **DWB 127/130** chain of nebulous knots, and the very bright nebula **IC 318**. Scallops of nebulous arcs lie between **DWB 134** and **DWB 136**. These may define the last remnant of shards of numerous supernova shock bubbles, or perhaps regions where several shock fronts met in collision. The nearly circular **DWB 78** is a curious object, almost a small bubble itself. However, no supernova candidate has been identified in its center.

The Cygnus Three Chart

Here we find an equally complex field, full of bright and interesting objects. **IC 1318** is the so-called Butterfly Nebula,



CYGNUS PANEL THREE

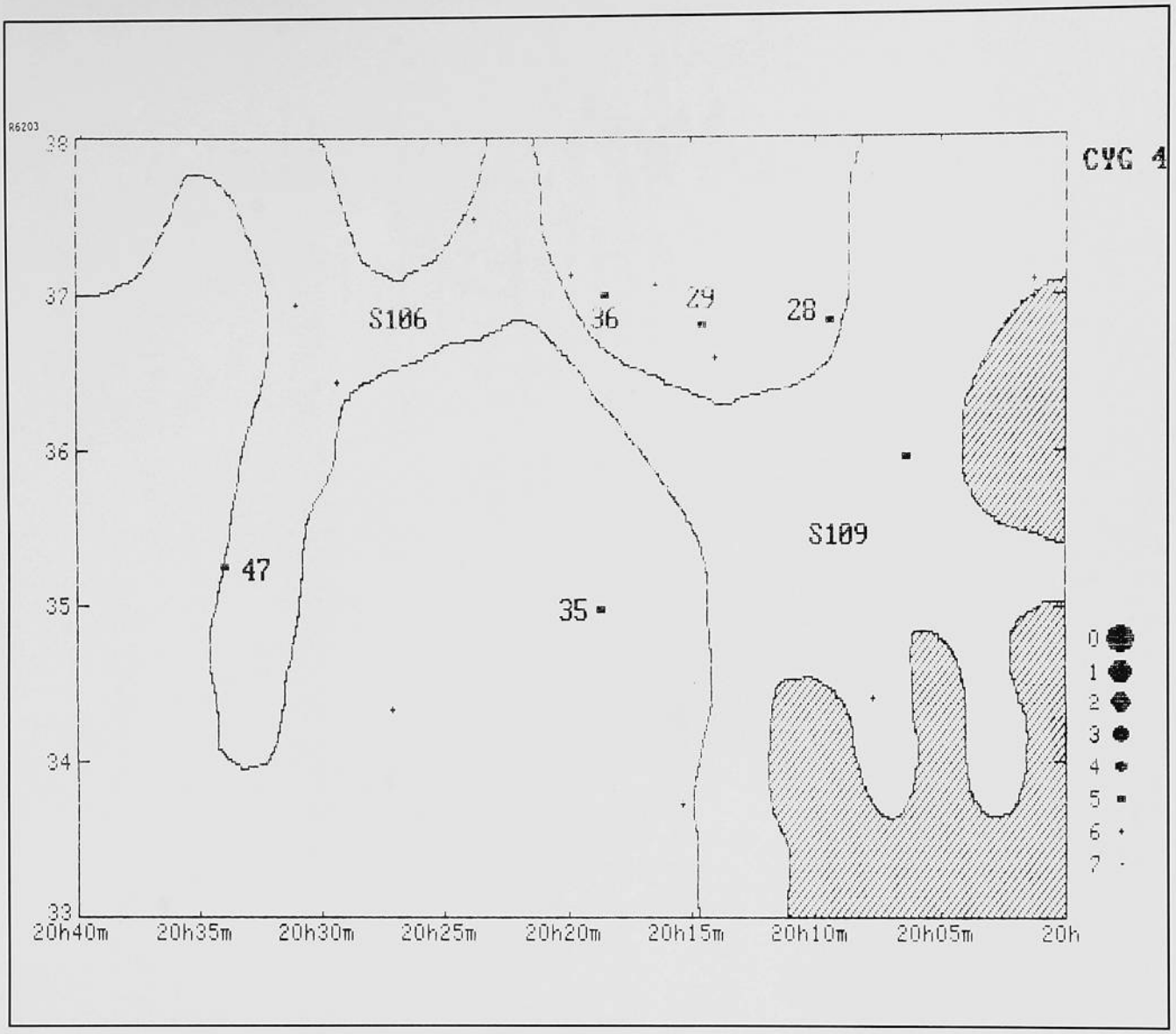
and lies just east of the magnitude 2.2 star Gamma Cygni. Easily visible in RFTs with a nebula filter, its dark knots and irregular outlines define the shape of a butterfly with open wings about to take flight. The strange nebula **Sharpless 2-108** is almost as bright. It is more diffuse in appearance than IC 1318, and contains several dark globules, speculated to be cocoons of dust surrounding newly formed solar systems. **NGC 6888** is a real gem. Also known as the Crescent Nebula or the Dividing Cell Nebula, this 18' by 12' gas bubble is the expanding shell of nebulosity around a 7th-magnitude Wolf-Rayet star. These stars are characterized by a fierce stellar wind, and push the local interstellar medium outward where it piles up and forms the edges of a shock front.

The Cygnus Four Chart

The field begins to thin out at the southern end of the Cygnus nebulosity complex. Dominating this region are the faint and extended nebulae **Sharpless 106** and **Sharpless 109**. Numerous large and irregular dark clouds of dust and gas lie in the southwest end of this field, one resembling the fingers on some giant Galactic hand.

Sweeping southward of the cross star Epsilon Cygni, we find the famous **Veil Nebula** (NGC 6960, NGC 6979, NGC 6992-5). This complete supernova remnant was discovered in 1784 by William Herschel. This fine, lace-like nebula is composed of several discrete arcs. Formed in a supernova blast some thirty to forty thousand years ago, this bright remnant can be seen in binoculars as a ring 2.6° in diameter. The brightest part of the ring, NGC 6992, is known as the Filamentary Nebula, and the fainter part of the wreath, NGC 6960, is called the Network Nebula. A surprising amount of detail is visible visually with a UHC filter and an 8-inch or 10-inch telescope. Photographically, the filaments are spectacular, with intertwining sections 1" to 5" wide chaining together to form several continuous arcs.

Just east of Deneb lie two grand regions of hydrogen clouds. The first is the **NGC 7000** complex, dominated by the North America Nebula itself. This magnificent object, some 100' across, is a mixture of both hydrogen gas and dust. Nearly 1,600 light-years distant, the nebula spans at least 45 light-years in extent. Astronomers have suggested that Deneb itself is the source of illumination for this nebula, but this has not been established firmly. Easily seen in RFTs, the true form of this object is best revealed by red light Schmidt camera photography. The Central America region is one of ex-



CYGNUS PANEL FOUR

quisite beauty, in which prime focus shots with large telescopes reveal numerous fine details. Just west is **IC 5067**, also known as the Pelican Nebula. Part of the same gas cloud as the North America, it is separated by an obscuring dust lane, **LDN 935**. About half the size of NGC 7000, the Pelican is much fainter, and can only be glimpsed fleetingly in the telescope even with a nebular filter. Photographically,it is an easy object for the red light astrophotographer, with much internal detail and dark lanes of dust within. South of the pair, is a broken arc of dim nebulosity **IC 5068**.

Further east lies **Sharpless 119**. It consists of a 2°-diameter broken ring with brighter east and west ends. Also at the same distance as the North America Nebula complex, this dim nebula is often overlooked but is often recorded in 50mm piggyback shots. Not plotted on most atlases, it can be found on the Skalnate Pleso *Atlas of the Heavens* as an undistinguished cloud of hydrogen.

Northeast of Sharpless 119 we find **IC 5146**, affectionately known as the Cocoon Nebula. Composed of both dust and gas, this very low surface brightness object is seldom swept up in casual searches. About 12' in diameter, this faint glowing circular cloud has as the source of illumination a 10th-magnitude B type star. Photographically, it deserves both wide angle lenses and prime focus shots. Since it is at the end of a 3°-long, narrow, dark dust lane in the Milky Way, the wide field camera is best suited to capture the entire vista. Prime focus shots with fast hypered films however reveal a round, orangish object with diffuse edges and internal dark dust lanes that divide up the nebula. The orange glow is surrounded by a blue halo of reflection nebulosity, making for a very unique and spectacular object. Little else is known about this faint cloud other than it lies in a vast region of dust on the periphery of the Cygnus nebulosity complex.

By simply using a camera, some film, and a few filters, you can greatly expand your knowledge of the distribution of our Galaxy's great hydrogen clouds and ancient remnants of supernovae. Using the amplified eye of the red light camera, you'll perceive the extensive filamentary framework of that luminous band we call the Milky Way in an entrirely new way.

Chris Schur is a longtime contribitor to Deep Sky *and an avid astrophotographer living in Payson, Arizona.*

Discover the Unknown Globulars of Sagittarius

Everyone knows about M22, M55, and M70 — now turn your attention to the really challenging globulars in Sagittarius

by Robert Bunge

Globular star clusters are fun to observe. In small telescopes, the biggest and brightest globulars are resolved, at least partially, into individual stars. In large telescopes, everyone who sees them marvels at the sight of thousands of stars tightly packed into a single field of view.

These clusters offer many challenges to deep-sky observers, ranging from picking out the planetary nebula in M15 to nailing down the faint Palomar clusters with larger scopes, to resolving the outer edges of M13 with a 3-inch telescope. A favorite challenge of many northern observers is to locate Omega Centaruri, the biggest and brightest globular. This isn't an easy task because it's only a few degrees above the southern horizon for many northern observers.

Globulars form a huge halo around the Milky Way Galaxy. In relation to other types of objects visible in backyard telescopes, they are also in scarce supply — only about 150 are visible. Because of their limited numbers, it's quite possible to observe them all. I decided to do this a few years ago, so typically whenever time, weather and other observing projects allow it, I have been slowly picking them off. But every once in a while I get into a frenzy. I was in such a frenzy as I started to observe globulars in the southern reaches of Sagittarius. Because I had observed the Messier objects in the past, I was now interested in the dimmer, non-Messier globulars.

There are a total of 20 globulars in Sagittarius listed in the *Revised New General Catalogue* (*RNGC*). Seven of them are Messier objects, leaving 13 *RNGC* objects. In addition, other sources of globular clusters add to the list. These include the Palomar list, a collection of globulars discovered by examining the *Palomar Observatory Sky Survey* (*POSS*) plates. Astrophysicist Yervant Terzian also complied a list of faint, obscured globulars that were discovered in the infrared. Thankfully, to ease the burden on observers, Wil Tirion plotted both the Palomar and Terzian globulars, along with a few others, in *Uranometria 2000.0*. These objects bring the number of globulars in Sagittarius to just under thirty.

Many of these objects are bright enough to be seen with small telescopes. Indeed, the faintest NGC globular has a visual magnitude of 9.8 and should be visible in most any amateur telescope. The Palomar and Terzian globulars, however, require larger scopes and very clear skies. A horizon clear of obstructions helps, too, as well as a large dose of careful, patient sweeping with a low-power eyepiece.

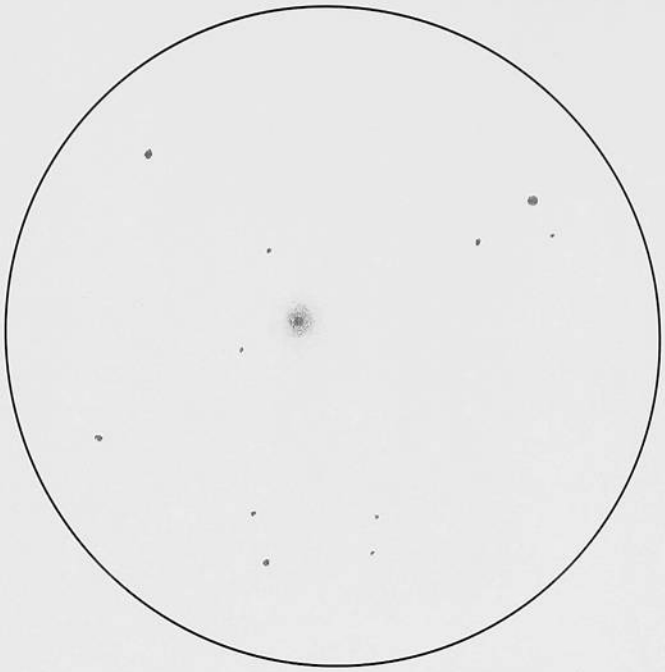
Despite his northern location, Sir William Herschel was able to find all but two of the NGC globulars with his 18.25-inch (20-foot) reflector from Slough, England in the later part of the 18th century. Early in the following century his son, Sir John Frederick William Herschel, observed all of these objects and discovered two more while observing with the same telescope from the Cape of Good Hope in the 1830s. Since then, most of these objects have been observed numerous times by observers.

For instance, lying about a degree southeast of Delta Sagittarii is the magnitude 8.3 cluster **NGC 6624**. With the 20-foot reflector, John Herschel observed 6624 during "sweep number 619" on August 15, 1835, and recorded the following description: "very bright; round; pretty; suddenly very much brighter in the middle; diameter in RA = 5.0' ; all clearly resolved into stars barely discernible." Herschel clearly thought of the object as a globular.

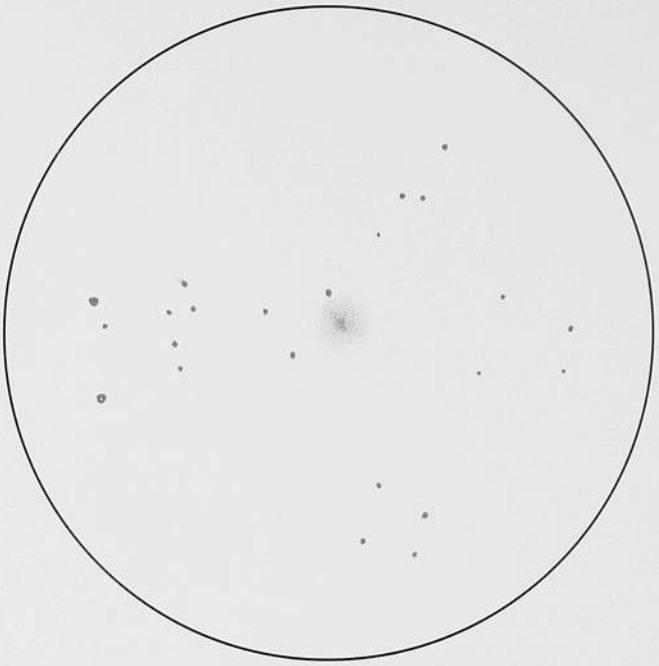
Some 150 years later Arizona amateur Steve Coe observed NGC 6624 with a 17.5-inch reflector. "NGC 6624 is bright, pretty large and round," noted Coe. "It has a very bright middle and is resolved at 165x. This is a nice globular that does not receive much attention from observers." When I looked at NGC 6624 with the 31-inch f/7 reflector at Warren Rupp Observatory in 1989, the cluster was easy to find, appeared to have a high surface brightness, and was easily seen with the 5-inch finder scope. With the main scope I thought the clusterwas clearly resolved into stars at 200x.

Another example, lying about a degree and a half from the Ophiuchus border, is **NGC 6440**. In his 1908 work *Nebuleus et D'Amas Stellaires*, Guillaume Bigourdan published his

Globs NGC 6522 and NGC 6528 photographed by Chuck Vaughn (14-inch f/11 SCT, hypered Tech Pan film, 20-minute exposure). Above: NGC 6522 sketched by Robert Bunge with a 31-inch reflector at 200x.



NGC 6440 sketched by Robert Bunge with the 31-inch scope at 200x.

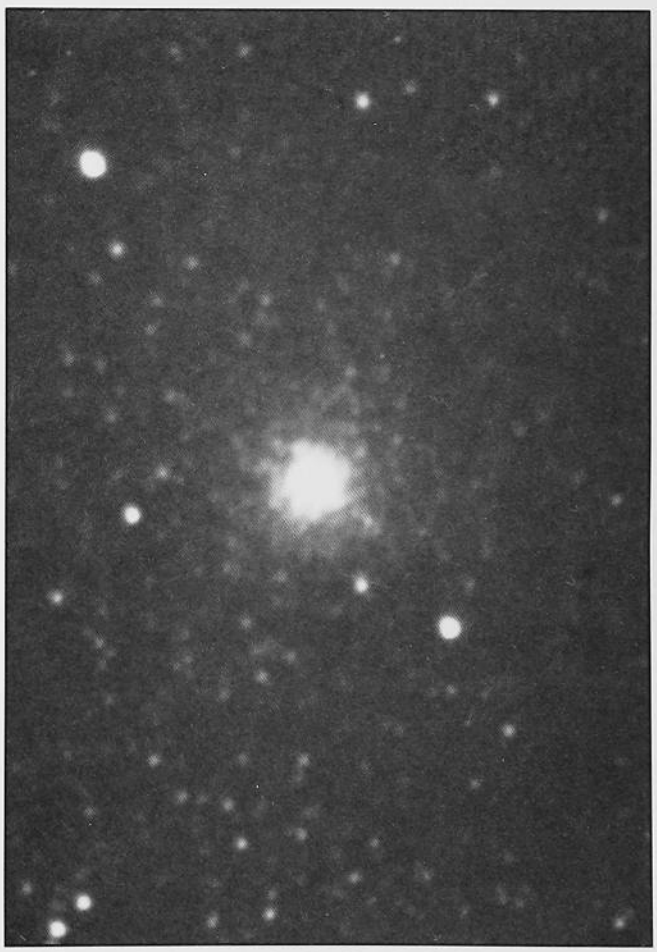


NGC 6528 sketched by Robert Bunge with the 31-inch scope at 200x.

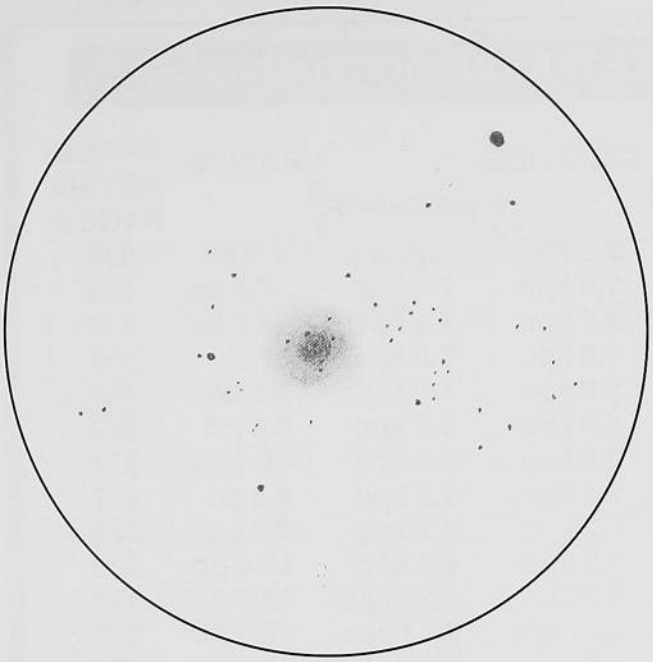
July 1890 observation of the cluster made with the 12-inch refractor at the Paris Observatory. "The object is rather brilliant and round," wrote Bigourdan. "It is 40" in diameter with a central region gradually more brilliant than the rest of the nebula." Apparently the cluster was not resolved. Coe looked at NGC 6440 with his 17.5-inch scope and called it "a rich globular cluster, pretty bright, small, much brighter middle with ragged edges; there were ten stars resolved." From northern Ohio, I used the 31-inch scope and could not see any resolved stars, most likely because of poor seeing (the great curse of large aperture telescopes), but did see some brightening toward the middle of the globular. (Incidentally, the bizarre planetary nebula NGC 6445 lies within the same low-power field as this impressive globular.)

I started my hunt for these globulars by pointing the 31-inch at M8, the Lagoon Nebula. South and east of M8 are two globulars, **NGC 6544** and **NGC 6553**. With the 31-inch, the bump down to NGC 6544 was just about half of a 25x finder field. The magnitude 8.3 globular was in a very rich field of stars and was completely resolved. I couldn't help but wonder why I had not bothered to look at this object all the times I've looked at the Lagoon. In 1886, Bigourdan thought this globular was vaguely round, but perhaps a little irregular with stars resolved in the Paris 12-inch refractor. About the same distance south and east is NGC 6553. John Herschel identified this object as a globular that appears "very faint; a little oval; very gradual little brightening toward the middle; barely resolved with a diameter of 7.5'." I resolved this cluster with the 31-inch at a magnification of 200x. It appeared pretty much round and was a pretty object.

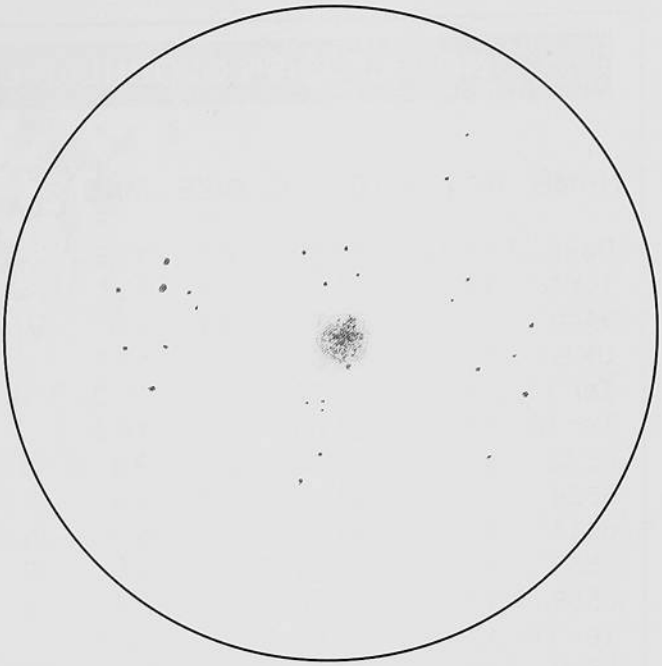
Almost directly west of NGC 6553 is the challenging cluster **Terzian 10**. Modern references give this object a visual magnitude of 14.9 and an almost stellar apparent diameter of 0.3 arcminute. A high-power search with the 31-inch scope failed to differentiate this globular from stars in the area. A detailed finder chart, perhaps made from a *POSS* print, might help a new search. Two other nearby globulars include **Terzian 9** and **UKS 1751-241**. The latter is a globular discov-



NGC 6440 photographed by Martin C. Germano (8-inch f/10 SCT, hypered Tech Pan film, 50-minute exposure).



NGC 6544 sketched by Robert Bunge with the 31-inch scope at 200x.



NGC 6642 sketched by Robert Bunge with the 31-inch scope at 200x.

NGC 6544 (near the Lagoon Nebula) photographed by Gary Capps.

ered using plates taken with the United Kingdom Schmidt telescope. I searched for this object with the 31-incher in vain. I did find magnitude 16.0 Terzian 9, a slightly fuzzy but almost starlike object right where it was supposed to be. Another Terzian cluster, **Terzian 5**, lies about 2° west of UKS 1751-241. I did not have time to search for this object, but with a magnitude 13.9 and a diameter of 2.1' it should be visible with amateur telescopes.

Next, I moved over to M22 and from there star hopped to nearby **NGC 6642**. I resolved this magnitude 9.4 object in the 31-inch. John Herschel also resolved this object with the 20-foot scope, and described it as round and pretty bright. South of NGC 6642, near the 2.2 magnitude star Lambda Sagittarii, is **NGC 6638**. This cluster was resolved in the 31-inch at 200x and was visible in the 5-inch finder. John Herschel thought NGC 6638 to be a "very delicate object" that was barely resolved — but he was sure it was a globular. Inside a group of several bright stars in the region of Upsilon[1] and Upsilon[2] Sagittarii is **NGC 6717**. This magnitude 9.2 globular was a pretty sight with Upsilon[2] in the same high power field. It was easily resolved. NGC 6717 is also listed as Palomar 9 in some references.

About two-thirds of the way along a line drawn between NGC 6717 and open cluster M25 lies **Palomar 8**. David Higgins described his observation of Palomar 8 in the Spring 1988 *Deep Sky*. Higgins warned that Palomar 8 — somewhat large at 4.7' — would have a low surface brightness and used 270x with a 24-inch telescope. I found it a challenging object in the 31-inch at 200x. It was not resolved.

My next target was the gorgeous pair of clusters **NGC 6522** and **NGC 6528**, located in the heart of the Milky Way near Gamma Sagittarii. These two globulars were in the same field of view at 170x, but I could not fit them both in at 200x, the magnification that seemed to be giving me the most detail. They were an interesting comparison. While NGC 6522 was clearly resolved, NGC 6528 was not, and appeared slightly smaller and dimmer. These two clusters seem to be a natural pair, but a glance at their location relative to

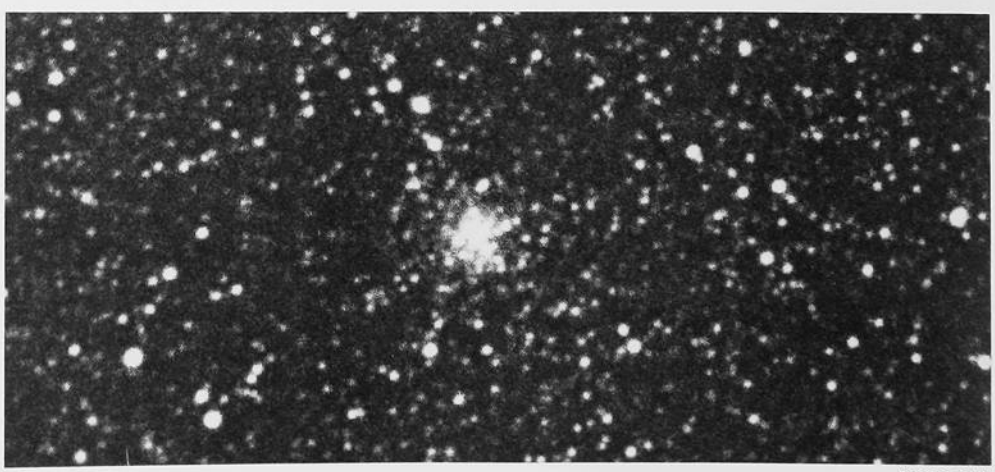
NON-MESSIER GLOBULAR CLUSTERS IN SAGITTIARIUS

NAME	RA (2000.0)	DEC	SIZE '	MAG^{V}	CLASS	DISTANCE^{GC}	DISTANCE$^{\odot}$	RADIUS	URANO-METRIA PAGE #
Pal 6	17 43.7	-26 13	7.2	11.8	-	2.9 kpc	5.9 kpc	2.9 pc	338
Ter 5	17 48.1	-24 47	2.1	13.9	-	1.8 kpc	7.1 kpc	37.8 pc	339
6440	17 48.9	-20 22	5.4	9.0	V	2.1 kpc	7.1 kpc	24.7 pc	339
UKS1	17 54.4	-24 09	0.6	17.3	-	1.8 kpc	7.0 kpc	17.7	339
Ter 9	18 01.8	-26 52	-	16.0	-	1.9 kpc	14.6 kpc	5.5 pc	339
Ter 10	18 03.6	-26 05	0.3	14.9	-	5.9 kpc	6.6 kpc	6.4 pc	339
6522	18 03.6	-30 02	5.6	8.4	VI	2.3 kpc	6.8 kpc	19.1 pc	377
6528	18 04.8	-30 03	3.7	9.5	V	2.1 kpc	2.6 kpc	9.3 pc	377
6544	18 07.3	-25 00	8.9	8.0	IX	6.2 kpc	5.7 kpc	8.8 pc	339
6553	18 09.3	-25 54	8.1	8.0	XI	3.2 kpc	8.8 kpc	17.4 pc	339
6558	18 10.3	-31 46	3.7	9.8	-	0.9 kpc	23.7 kpc	16.2 pc	377
Ter 11	18 12.1	-22 44	-	16.4	-	15.1 kpc	23.7 kpc	13.8 pc	339
6569	18 13.6	-31 50	5.8	8.7	VIII	1.0 kpc	8.9 kpc	18.3 pc	377
6624	18 23.7	-30 22	5.9	8.0	VI	1.5 kpc	8.0 kpc	26.8 pc	378
6638	18 30.9	-25 30	5.0	9.0	VI	2.5 kpc	6.7 kpc	11.5 pc	340
6642	18 31.9	-23 29	4.5	9.4	V	3.6 kpc	5.5 kpc	12.8 pc	340
6652	18 35.8	-32 59	3.5	8.8	VI	6.0 kpc	14.3 kpc	32.3 pc	378
Pal 8	18 41.6	-19 49	1.6	11.2	-	19.8 kpc	28.1 kpc	18.3 pc	340
6717	18 55.1	-22 42	3.9	9.2	VIII	2.6 kpc	7.8 kpc	18.0 pc	340
6723	18 59.6	-36 38	11.0	7.2	VII	2.7 kpc	9.2 kpc	33.6 pc	378
Ter 7	19 17.7	-34 40	-	12.0	-	28.4 kpc	36.4 kpc	36.8 pc	379
Arp 2	19 28.2	-30 21	-	12.3	-	20.4 kpc	28.3 kpc	46.3 pc	379
Ter 8	19 41.7	-34 00	-	12.4	-	40.4 kpc	48.2 kpc	122.2 pc	379

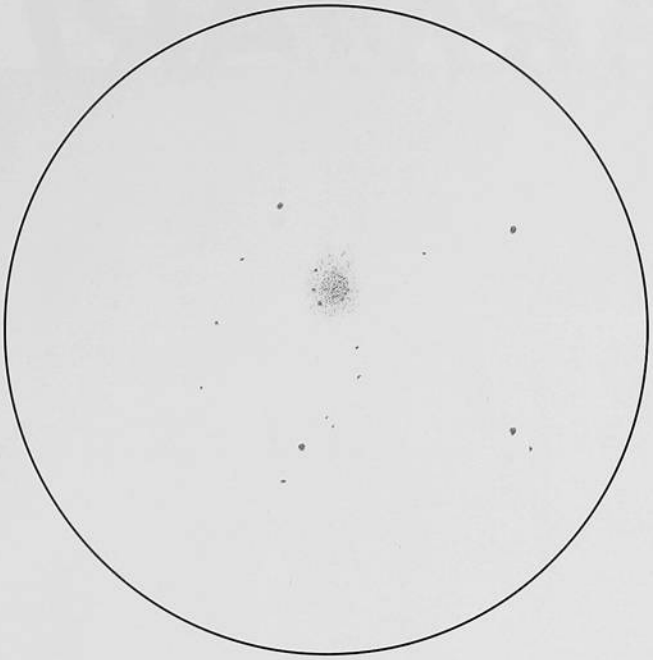
Notes: NGC6717 = Pal 9

Name: NGC, Terzian or Palomar number. **R.A. and Dec.**: Coordinates for epoch 2000.0. **Size**: Angular size in arcminutes. **Mag.^{V}**: Visual magnitude of cluster. **Class**: Shapley classification. **Distance^{GC}**: Distance from cluster to galactic center in kiloparsecs. **Distance$^{\odot}$**: Distance from cluster to the Sun in kiloparsecs. **Radius**: Linear radius in parsecs. **Uranometria Page #**: Number of Uranometria chart on which object is plotted. **Sources**: Webbink, Alcaino, NGC2000, Webb #7, Skiff and Shapley.

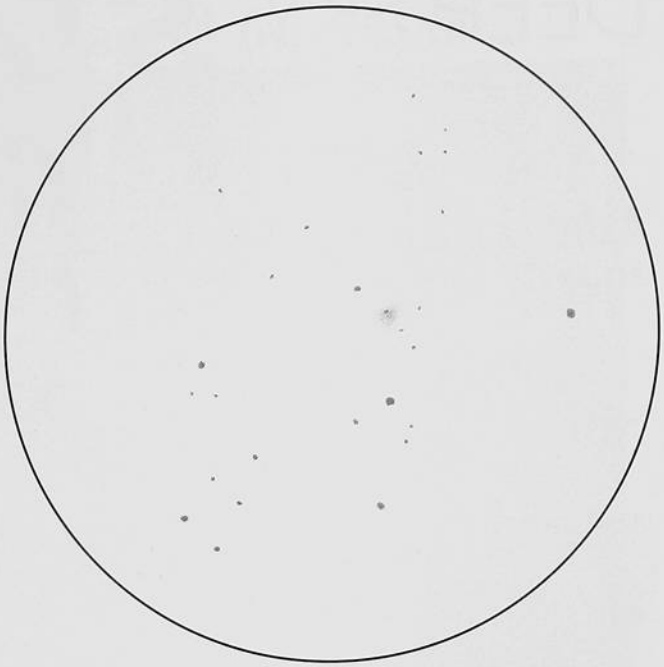
Chart by Robert Bunge



NGC 6642 photographed by Martin C. Germano (8-in ch f/10 SCT, 103a-F film, 60-minute exposure).



NGC 6723 sketched by Robert Bunge with the 31-inch scope at 200x.



Terzian 9 sketched by Robert Bunge with the 31-inch scope at 340x.

NGC 6723 and its area photographed by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 30-minute exposure).

the center of the Galaxy shows we are only seeing a chance alignment. Although NGC 6522 was easy to resolve, it is almost three times more distant than NGC 6528. NGC 6522 is also about twice as large as its so-called neighbor.

Herschel observed 6528 twice from the Cape and resolved it both times. But he appeared to be more impressed by the richness of the field around NGC 6528. "This and I.49 (NGC 6522) occur on a ground so astonishingly rich and stipped over with stars individually discrenible, as hardly to admit a pin's point between the stars, and this fills more than the whole field or many fields," he wrote after observing the two on August 3, 1834.

Another pair of globulars lies southeast of NGC 6522 and NGC 6528. **NGC 6558** and **NGC 6569** also offer proof that not all globulars look the same. NGC 6569 was resolved across its 5.8' diameter except at the core, where no brighter stars allowed themselves to be seen. It reminded me of M13 in a 6-inch telescope at high power. NGC 6558, on the other hand, was not resolved and required averted vision to see.

Between and a little south of M69 and M70 lies **NGC 6652**. This magnitude 8.8 object was partially resolved in the 31-inch and had a high surface brightness that made it easy to see. It also appeared to have a very small, bright core. Slightly farther south we can find **NGC 6723**. Visible in the 5-inch finder scope at 25x, this object was very nicely resolved in the 31-inch even though it appears to have a low surface brightness. It also shows an odd, interesting shape — it appears to be squared off on two sides.

Several other clusters lie in the area and should be visible in backyard telescopes. These include **Arp 2**, **Terzian 7**, **Terzian 8** and **Palomar 6**. Each of these clusters has a visual magnitude brighter than 12.5 and deserves the attention of amateurs in search of a challenge. All four of these objects are plotted on *Uranometria*.

Robert Bunge is an avid observer living in Columbus, Ohio. He is a frequent contributor to Deep Sky.

DEEP SKY STARMART

Astro Library
BOOKS

Astronomical Tables of the Sun, Moon, and Planets A comprehensive listing of past, present and future celestial events. 391 pgs., soft cover. 30044/$20.50

Astrophotography A clearly written guide for the beginner. 2nd Ed. 208 pgs., soft cover. 30125/$19.95

Astrophotography II Intermediate/advanced manual for the astrophotographer. Covers developers, film and filters. 176 pgs., soft cover. 30150/$19.95

Build Your Own Telescope Instructions for building five amateur telescopes. By Richard Berry, Editor-in-Chief of ASTRONOMY. 276 pgs., hard cover. 30124/$25.95

Colours of the Stars Uses spectacular photography to explain what color is in stars, galaxies and nebulae. 198 pgs., hard cover. 30076/$37.50

The Universe from Your Backyard
URANOMETRIA 2000.0
Volume II
The Southern Hemisphere to +6°
ASTRONOMY
BUILD YOUR OWN TELESCOPE
Complete Plans for Five High-quality Telescopes that Anyone Can Build
RICHARD BERRY
Deep-Sky Observing With Small Telescopes

Deep-Sky Observing with Small Telescopes An anthology that describes many deep-sky objects to view with small backyard telescopes. From the editors of *Deep Sky*. 336 pgs., soft cover. 30188/$29.95

The Facts on File Dictionary of Astronomy How to speak astronomy: an excellent reference of concepts, definitions and terms. Revised. 437 pgs., hard cover. 30013/$24.95

Field Guide to the Stars and Planets A handy pocket-size guide to the heavens, complete with star charts and viewing advice. 473 pgs., soft cover. 30046/$13.95

How to Make a Telescope How to grind, polish and test the optics for a Newtonian telescope; includes instructions on making a mounting. 2nd Ed. 424 pgs., hard cover. 30048/$19.95

Introduction to Asteroids The latest information on these small bodies – their history, physical nature and their occasional impact on Earth. 208 pgs., soft cover. 30170/$19.95

NGC 2000.0 A centennial reissue of Dreyer's New General Catalogue with updated data. 273 pgs., soft cover. 30187/$19.95

Sarna Deep Sky Atlas These 102 charts will lead you and your telescope to hundreds of deep-sky objects. 30072/$29.95

Sky Atlas 2000.0 The best general purpose star atlas for every backyard observer. 26 charts, 16" x 11". 30022/$39.95

Sky Catalog 2000.0 Handy, hard-to-find data on many astronomical objects; conveniently arranged. 770 pgs. total, soft cover. **Vol. 1,** Stars to magnitude 8.0 30023/$29.95; **Vol. 2,** Double stars, variable stars and non-stellar objects.30024/$29.95

Telescope Optics: Evaluation and Design This book will arouse your curiosity and answer your questions about buying and building telescopes. 375 pgs., hard cover. 30175/$24.95

The Universe From Your Backyard A guide for backyard astronomers providing tips on finding 690 of the most fascinating Deep-Sky objects. 188 pgs., hard cover. 18037/$24.95

Uranometria 2000.0 The essential star atlas for amateur observers; plots 250,000 stars and thousands of deep-sky objects. 565 pgs. total, hard cover. **Vol. 1**: The Northern Hemisphere to -6° declination, 30156/$39.95; **Vol. 2:** The Southern Hemisphere to +6°, 30157/$39.95

Sky Stuff
PRODUCTS OF ASTRONOMICAL INTEREST

The Best Deep Sky Objects Handy, durable map of locations of nebulae, clusters and galaxies and a table of positions. 10" x 11" card. 18029/$1.50; 5 or more 50¢ each.

Miller Planispheres Identify stars and note their progressions using this durable plastic wheel. 30° N, 10.5" 30190/$9.95; 40° N, 10.5" 30189/$9.95

1991 Exploring the Universe Calendar Celebrate each month with a full-color, 11" x 14" astrophotograph, a descriptive essay and an appointment calendar. 68060/$9.95

TO ORDER CALL TOLL FREE
(800) 446-5489

(weekdays 8:30 - 5:00 CST)

Please have your credit card ready.
Include for postage and handling: U.S. $3.00; Canada and foreign add 18% (min. $4.00).
Canadian orders add 7% GST to total. Wisconsin residents add 5% sales tax. Payable in U.S. funds.
Prices and availability subject to change.

KALMBACH PUBLISHING CO., DEPT. D0273, 21027 CROSSROADS CIRCLE, P.O. BOX 1612, WAUKESHA, WI 53187-1612

Dept. D0273

20 Palomar Sky Survey Images* for $15.00

MicroSky™—A microfiche reproduction of the Palomar Sky Survey (PSS)

- **This is a market test.** Deen Publications has the right to reproduce these 20 PSS plates. Whether or not it can reproduce the entire 936-plate PSS may depend on the response to this test, which will be used to estimate the size of the market.
- **Target price is $200 for the complete survey.** The actual subscription price will depend on the estimated market size. The larger the market, the lower the price. It could be as low as $150 or as high as $500. Compare this to about $6,000 for a complete set of full sized PSS prints. Your $15 purchase price of these two microfiches will apply toward the subscription price.
- **Charter subscriber discount.** The first 200 purchasers of these first two ***MicroSky***™ microfiches will be classified as charter subscribers. They are guaranteed that a complete subscription will cost the lesser of $150 or 80% of the non-charter price.
- **Viewers .** Used desktop microfiche viewers are available from $50 to $100. Hand-held viewers are available from $25.
- **Professional resource.** The PSS, taken with a 48-inch Schmidt Camera, is the finest photographic sky atlas in the world. This unique atlas can be used to great advantage by deep sky observers, astrophotographers, and comet and supernova hunters.
- **No loss of detail.** The inset is 2x the PSS plate scale and approximately full size for a 24x viewer. It covers about 0.5°x 1.2°.
- **Sub-catalogue listing.** Catalogue names and *x-y* coordinates in mm (full scale, relative to the lower left corner of the plate) of bright stars and non-stellar objects appearing in each frame of the microfiche are listed in the margin of that frame.
- **Square grid overlay.** The 35 cm x 35 cm square grid does not block star images. Millimeter scales are printed along the edges. The grid is necessary because the edge scales are generally outside the viewer's magnified field of view.
- **Positive transparencies.** The PSS is reproduced on negative prints. For projection, positive transparencies are best.
- **Flip it over for a mirror image.** This is very helpful when viewing the sky through a star diagonal mirror.
- **Subsets.** Specialized subsets of the PSS will be offered. The $15 initial purchase and the charter subscriber discount will apply.
- **May 1, 1991 delivery.** The target delivery date for the first two ***MicroSky***™ microfiches is May 1, 1991.
- **15-day money back guarantee.** If you are not completely satisfied, return ***MicroSky***™ within 15 days for a full refund.

Deen Publications, P.O. Box 831991, Richardson, TX 75083, (214) 517-8485

MasterCard VISA

* The following 20 blue-sensitive PSS plates are reproduced in two 4x6-inch microfiches: 1023, 1033, 1061, 1063, 1066, 1077, 1385, 1401, 1405, 1420, 1560, 1561, 1563, 1572, 1576, 1578, 1591, 1595, 1600, and 1611. Twenty PSS prints cost about $128 from Caltech. Each 14-inch square PSS plate covers 6.4° square and is reduced to about 30 mm square in the microfiche. This group covers from about +20° 24' to -15° 59' and from about 11h 54' to 13h 32'. The $15 price includes domestic postage. Foreign orders add $1 for airmail.

Deep Sky Reports

The "Deepest" Deep-Sky Objects

by Todd Hansen

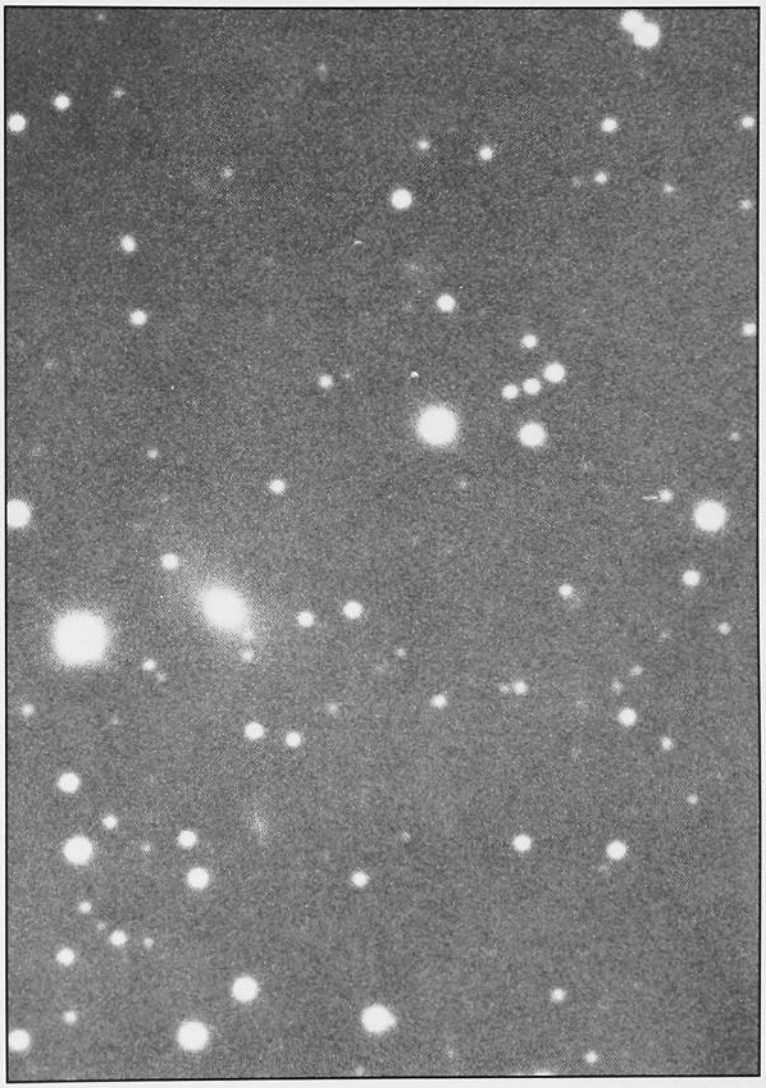
For a quarter of a century, quasars and BL Lacertae Objects have had as much interest and speculation as any astronomical objects. Their fame centers on one property, the redshift of their spectral lines. Originally located as powerful radio sources, the spectra of some quasars were identified in 1963 as having larger redshifts than any galaxy.

Should redshifts be largely due to a cosmological expansion of the universe, commonly accepted since Edwin Hubble's research in the 1920s, then high quasar redshifts would imply that they are more distant than galaxies in time as well as in space. In the mid-1970s, another class of astronomical objects was recognized as having a similar cosmological nature. These objects are named after the odd variable galaxy BL Lacertae.

The cosmological explanation for a high redshift — that the object's redshift is exponentially proportional to its distance — remains the most viable idea. This means that light from the quasar 3C 273 with a redshift of z = 0.158 may have been traveling three billion years across the universe before reaching an earthbound telescope. The light visible from most quasars can be older than Earth itself! Current research on the nature of Quasars and "BLOs" concentrates on the idea that they are a step in the evolutionary process of galaxies, particularly in the massive cores.

These faint, starlike objects are not visually the most interesting deep-sky objects. But they are irresistible to me. Quasars and BL Lacertae Objects take us to the limits of our measure of space and time. And they are even more at our limits of understanding the nature and structure of our universe.

A handful of these objects are visible in smaller amateur telescopes, and many with moderate sized instruments. I started a search in 1978 to observe as many as possible. I used 6-inch and 10-inch Newtonians in an excellent rural seeing environment. The main trick in observing these usually very difficult objects is knowing exactly where to look. Consequently, most of the effort in making my observations was in determining what has been discovered, getting a finder chart or photograph specifying the exact object in a star field, and locating the field in the sky by using a star atlas.



This is a distinct type of observing, as the appearance is the least significant aspect of the observation — they are going to look like a star. My primary goal was to be positive the proper object was seen, and secondly to estimate its magnitude. The primary goal requires one to be confident with the technique of star-hopping while following a photograph and/or star atlas.

For example, I gained experience in star-hopping by visually exploring the fields of Hans Vehrenberg's *Atlas of Deep Sky Splendors*, attempting to visually locate anything he identified in his photographs. Confidence in the limiting magnitude of one's personal ability and one's telescope, as well as familiarity with true visual magnitudes, can be developed by the *AAVSO North Polar Sequence*. This is a set of charts of stars near the North Celestial Pole with magnitudes covering the range of any amateur telescope. I found that at my excellent rural location, with my 10-incher, I could positively see a magnitude 15.25 star, while only suspect seeing a magnitude 15.44 star.

Such extremely faint viewing requires a few observing tricks. You must use averted vision — that is, looking slightly to the side of the object to allow the more sensitive part of the eye to work. You must also use high power, which cuts down on the general background glow and thus increases the contrast of a faint starlike object to that background. Another requirement is to wait for the flashes of a barely visible object to come in as the atmospheric turbulence temporarily improves visibility. And of course the more experience you have, the more familiar you are with the difference between a true extremely faint object versus the ghosts that your own eye can generate. For

me, a positive sighting required the object to stay visible at least a couple of seconds, or to be detected in several flashes within a short time span.

For source catalogs, I have used primarily the "Bright Quasar Survey" published by Schmidt and Green in *Astrophysical Journal* **269:**352, 1983, and the catalogue assembled by Hewitt and Burbidge and published in *Astrophysical Journal Supplement Series* **43:**57, 1980. An important collection of finder charts is that published in Eric Craine's *A Handbook of Quasi-stellar and BL Lacertae Objects.* I typically use the charts in conjunction with one of Vehrenberg's photographic atlases. *Sky Catalogue 2000.0* and Burbidge, Crowne, and Smith's catalog in *Astrophysical Journal Supplement Series* **33:**113 are other good sources, and information and finder charts on a few key objects appeared in *Sky & Telescope* for April 1983.

Aside from Craine's book, the balance of references are buried throughout the professional journals. Therefore, I also needed a good research library, and give my thanks to the libraries of Stanford University, Lick Observatory, the University of California at Santa Cruz, and Michigan State University for the use of their periodical collections.

In some cases, the stars in a finder chart's field are clearly apparent in Vehrenberg's *Falkauer* or *Photographic Atlas*, which has a limiting magnitude of about 13, but in most instances identification requires *Atlas Stellarum*, which goes down to 14th magnitude. You need to be wary about the variation in magnitudes on a photographic atlas due to photographic sensitivity versus the human eye's sensitivity. Rarely, I also referred to the ultimate photographic atlas, the *Palomar Observatory Sky Survey.*

When I'm getting ready to observe, I usually photocopy the portion of the Vehrenberg chart I need, then pencil in the field of the finder to take outside for the observing session. Generally I have used the charts from both of Vehrenberg's atlases for all objects.

Another lesson I've learned is not taking too literally the published magnitudes, even when they imply an accuracy to two decimal places. Especially in the early published sources, a quasar's magnitude could vary widely from one reference to another. But more important, photographic magnitudes are usually given, and experience shows that visual appearance can be a magnitude different. Finally, many quasars are variable, especially BL Lacertae Objects. Because of this, the visibility of an object can change.

What follows are two tables describing those objects I have made positive sightings of, which reference material I used for finders, the size of telescope (if made with my 6-inch f/9 scope; otherwise all observations are with a 10-inch f/5.6 reflector), and an estimate of apparent visual magnitude and the date of the observation. The observations were made at 200x for the 6-incher, and 180x with the 10-inch scope.

Because observations are not matched with a known magnitude sequence, my magnitude estimates are essentially judgment calls based on the difficulty of seeing the object. I believe, based particularly on AAVSO's *North Polar Sequence*, that the limiting magnitude for my 10-inch scope at my site is about 15.4. The estimates for the fainter objects work backwards from that figure. The standard deviation for the magnitudes could be 0.2 magnitude, though I hope it is more like 0.1 magnitude.

The challenge and fun for me was the research and the observing effort to locate these objects for the first time. However, to be truly useful, they should be systematically observed for possible variability. An excellent program for the future would be a regular schedule, say once a month, of observing the apparent magnitudes.

My goal for this program was to try anything listed as brighter than magnitude 16.00. Naturally they must be high enough to be seen from my latitude (about 39.3° N), generally north of declination -40°. The purpose was to determine which ones could be seen with a mid-size amateur telescope. To that end, the following lists are as comprehensive as possible as to which quasars and BL Lacertae Objects are most accessible to amateur observers.

The Best Quasars For Backyard Scopes

1. **0008+107** (II Zw 2). 0h 08m00s, +10°42'00" (equinox 2000.0 coordinates). z = 0.089. Craine with *Falkauer* #160. M = 15.0 on 8 August 1980.

2. **0026+129**. 0h26m28s, +12° 59'29". z = 0.142. *PASP* **88:**665 with *Atlas Stellarum* #160. M = 15.2 on 11 September 1983.

3. **0051+124** (I Zw 1/ PHL 3072). 0h50m58s, +12°25'19". z = 0.061. *ApJ* **160:**405, *POSS* #467, and *Atlas Stellarum* #161. M = 14.5 on 10 January 1989.

4. **0205-024**. 2h05m12s, +2° 28'55". z = 0.155. Craine with *Atlas Stellarum* #199. M = 15.4 on 24 January 1981.

5. **0405-123**. 4h05m27s, -12°19'32". z = 0.574. *Sky & Telescope* April 1983 with *Falkauer* #238. M = 14.6 or brighter on 31 December 1983.

6. **0754+394**. 7h54m38s, +39°28' 24". z = 0.096. *ApJ* **261:**51 with *Atlas Stellarum* #73. M = 14.4 on 10 January 1989.

7. **TON 951** (0844+349). 8h44m 34s, +34°56'09". z = 0.064. *Bol. Ton y Tac* **2:**18 with *Atlas Stellarum* #103. M = 14.0 on 11 January 1989.

8. **Markarian 705** (0923 +129). 9h23m20s, +12°57'06". z = 0.029. *Astrofizika* **12:**389 with *Atlas Stellarum* #174. M = 14.9 on 11 January 1989.

9. **0953+414**. 9h53m48s, +41° 29'58". z = 0.239. *ApJ* **239:**483 with *Atlas Stellarum* #75. M = 15.2 on 26 February 1989.

10. **1004+130** (4C 13.41). 10h 04m45s, +13°03'37". z = 0.240. Craine with *Atlas Stellarum* #175. M = 15.2 on 4 January 1984.

11. **TON 490** (1011+250). 10h11m 06s, +25°04'10". z = 1.631. Craine and *Sky & Telescope* April 1983, with *Falkauer* #105. M = 15.3 on 4 January 1983.

12. **TON 34** (1017+280). 10h17m 06s, +28°01'00". z = 1.924. *Bol. Ton y Tac* **2:**16 with *Atlas Stellarum* #105. Note: *Sky & Telescope* for April 1983 gives the wrong declination sign for this object. M = 15.3 on 4 January 1984.

13. **3CR-249.1** (1100+772). 11h00m 31s, +77°15'08". z = 0.311. Craine with *Falkauer* #5. M = 15.2 on 29 January 1984.

14. **1101-325**. 11h01m08s, -32°35' 05". z = 0.354. *Astron. Lett.* **13:**187 with *Atlas Stellarum* #318. M = 14.9 on 4 January 1984.

15. **1103-006** (4C 00.43). 11h03m 58s, -00°36'38". z = 0.426. *Austral. J. Physics* **23:** 789 with *Atlas Stellarum* #212. M = 15.4 on 12 January 1984.

16. **1115+080A**. 11h15m41s, +08° 02'24". z = 1.722. *ApJ* **239:**483 with *Atlas Stellarum* #176. M = 15.2 on 7 April 1989.

17. **TON 1388** (1116+215). 11h16m 30s, +21°35'43". z = 0.177. *Bol. Ton y Tac.* **2:**18 with *Atlas Stellarum* #140. M = 15.0 on 8 April 1989.

18. **Markarian 734** (1119 +120). 11h19m11s, +12°00'46". z = 0.049. *Astrofizika* **12:**389 with *Atlas Stellarum* #176. M = 14.8 on 7 April 1989.

19. **1148+549**. 11h48m43s, +54°54' 18". z = 0.969. *ApJ* **269:**352 with *Atlas Stellarum* #51. M = 15.1 on 8 April 1989.

20. **1151+117**. 11h51m16s, +11°45' 10". z = 0.176. *ApJ* **269:**352 with *Atlas Stellarum* #177. M = 15.3 on 7 April 1989.

21. **1225+317**. 12h25m56s, +31°45' 13". z = 2.200. Craine and *Sky & Telescope* April 1983, with *Atlas Stellarum*

#108. M = 15.2 on 29 January 1984.

22. **3C 273** (1226+023). 12h26m 33s, +2°19'42". z = 0.158. *Sky & Telescope* June 1964 and *AAVSO Chart* 1224+02 B, D. M = 12.5-12.6 on 12 May 1977; 12.8 on 21 June 1979; 12.3 on 5 July 1980.

23. **1302-102**. 13h02m56s, -10°17' 17". z = 0.286. Craine with *Falkauer* #251. M = 15.3 on 8 April 1989.

24. **1307+085**. 13h07m16s, +8°35 '47". z = 0.155. *ApJ* **269:**352 with *Atlas Stellarum* #179. M = 15.2 on 30 May 1989.

25. **TON 153** (1317+277). 13h17m 34s, +27°43'52". z = 1.022. Craine and *Sky & Telescope* April 1983 with *Atlas Stellarum* #109. Note: In the Sky & Telescope article the quasar's declination sign is reversed. M = 15.3 on 12 January 1984.

26. **TON 182** (1402+261). 14h02m 59s, +26°09'59". z = 0.164. *Bol. Ton y Tac* **16:**3 with *Atlas Stellarum* #110. M = 15.3 on 31 May 1989.

27. **1435+630**. 14h35m37s, +63°49' 31". z = 2.060. *Astron. Ap. Suppl.* **29:**139 with *Atlas Stellarum* #329. M = 15.3 on 29 January 1984.

28. **1448+273**. 14h48m59s, +27°21' 42". z = 0.065. *ApJ* **269:**352 with *Atlas Stellarum* #111. M = 15.0 on 31 May 1989.

29. **152+227** (OR 241). 15h 25m46s, +22°43'23". z = 0.253. Craine with *Falkauer* #147. M = 15.4 on 29 January 1984.

30. **Markarian 290** (1534+580). 15h 34m45s, +58° 04'00". Quasar? z = 0.030. *Astrofizika* **5:**581 with *Atlas Stellarum* #33. M = 15.3 on 31 May 1989.

31. **TON 256** (1612+262). 16h12m 09s, +26°11'46". z = 0.131. Craine with *Atlas Stellarum* #113. M = 15.2 on 1 February 1984.

32. **1634+706**. 16h34m52s, +70°37' 37". z = 1.334. *ApJ* **269:**352 with *Atlas Stellarum* #18. M = 14.9 on 6 August 1988.

33. **1700+518**. 17h00m13s, +51°53' 37". z = 0.292. ApJ 269:352 with Atlas Stellarum #57. M = 15.3 on 5 August 1988.

34. **3C 351** (1704+608). 17h04m 04s, +60°48'29". z = 0.371. Craine and *ApJ* **144:**459 with *Falkauer* #34. M = 15.2 on 8 August 1980.

35. **1718+481**. 17h18m18s, +48°07' 11". z = 1.084. *ApJ* **269:**352 with *Atlas Stellarum* #57. M = 14.8 on 5 August 1988.

36. **2130+099** (II Zw 136). 21h30m 00s, +9°56'00". z = 0.061. *PASP* **80:**235 with *Falkauer* #192. M = 14.8 on 8 August 1983.

37. **2141+175**. 21h41m14s, +17°30' '02". z = 0.210. Craine with *Atlas Stellarum* #156. M = 15.4 on 3 August 1983.

38. **2201+315** (4C 31.63). 22h01m 01s, +31°31'10". z = 0.297. Craine with *Falkauer* #121. M = 15.0 on 8 August 1980.

39. **Markarian 304** (2214 +139). 22h14m45s, +13°59'27". z = 0.067. *Astrofizika* **7:**511 with *Atlas Stellarum* #193. M = 15.1 on 26 December 1988.

40. **MR 2251-178**. 22h51m 26s, -17°50'54". z = 0.0680. *Nature* **271:**35 and *Sky & Telescope* December 1978, with *Falkauer* #302. M = 14.7 on 8 August 1980.

41. **2308+098** (4C 09.72). 23h08m 47s, +9°51'56". z = 0.432. Craine and *Falkauer* #194. M = 15.3 on 8 August 1980.

The Best BL Lacertae Objects for Backyard Telescopes

1. **Markarian 335** (0003 +199). 0h 03m45s, +19°55'30". z = 0.025. *Astrofizika* **7:**511 with *Atlas Stellarum* #124. M =13.8 on 10 January 1989.

2. **0119+229**. 1h19m57s, +22°54' 35". z = 0.053. *ApJ* 269:352 with *Atlas Stellarum* #125. M = 15.3 on 5 February 1989.

3. **3C 66A** (0219+428). 2h 19m30s, +42°48'30". z= ? Craine and *Falkauer* #66. M = 14.8 on 8 August 1980; 15.2 on 11 September 1983.

4. **0521-365**. 5h21m14s, -36° 30'00". z = 0.06. Craine with *Falkauer* #342. M = 14.8 on 13 December 1980.

5. **0537-441**. 5h37m09s, -44° 06'40". z = ? Craine with *Atlas Stellarum* #342. M = 14.5? on 16 January 1982.

6. **0548-322**. 5h48m50s, -32° 16'56". z = 0.069. Craine with *Falkauer* #311. M = 15.3-15.4 on 13 December 1980.

7. **0735+178**. 7h35m14s, +17°49' 09". z = ? Craine with *Atlas Stellarum* #135. M = 15.1 on 4 April 1981.

8. **0851+203** (OJ 287). 8h51m57s, +20°17'59". z = ? Craine and *Sky & Telescope* April 1983, with *Atlas Stellarum* #137. M = 15.2 on 2 January 1984.

9. **Markarian 421** (1101 +385). 11h01m41s, +38°28'43". z = 0.0308. Craine: bright star 51 Ursae Majoris in same field. M = 13.1 on 28 May 1979; 13.1 on 29 May 1981.

10. **Markarian 1298** (1126-041). 11h26m44s, -04°07'35". z = 0.060. *Astrofizika* **15:**363 with *Atlas Stellarum* #213. M = 15.2 on 7 April 1989.

11. **Markarian 180** (1133 +704). 11h33m30s, +70°25'. z = ? *Astrofizika* **5**:443 with *Atlas Stellarum* #15. M = 15.0 on 8 April 1989.

12. **1211+143**. 12h11m45s, +14°19' 53". z = 0.085. *ApJ* **269:**352 with *Atlas Stellarum* #178. M = 14.8 on 8 April 1989.

13. **1215+303** (ON 325). 12h15m 21s, +30°23'40". z = ? *Nature* **231:**515 with *Falkauer* #108. M = 15.0 on 29 January 1984.

14. **Markarian 205** (1219 +755). 12h19m30s, +75°35'00". z = 0.070. Craine with *Falkauer* #6. M = 15.3? on 14 June 1980.

15. **TON 1542** (1229+204). 12h29m 48s, +20°25'00". z = 0.064. Craine with *Atlas Stellarum* #142. M = 15.2 on 26 June 1981.

16. **Markarian 662** (1351 +236). 13h51m46s, +23°40'30". z = 0.055. *Astrofizika* **10:**307 with *Atlas Stellarum* #144. M = 15.3 on 30 May 1989.

17. **1351+640**. 13h51m46s, +64°00' 28". z = 0.088. *PASP* **88:**665 with *Falkauer* #32. M = 15.0 on 3 July 1983.

18. **1411+442**. 14h11m50s, +44°14' 12". z = 0.089. *ApJ* **269:**352 with *Atlas Stellarum* #80. M = 15.0 on 31 May 1989.

19. **1416-129**. 14h16m21s, -12°56' 58". z = 0.129. *ApJ* **269:**352 with *Atlas Stellarum* #253. M = 15.2 on 8 April 1989.

20. **1418+546**. 14h18m06s, +54°36' 44". z = ? *ApJ. Letts.* **223:**L67 and *Ap. Suppl.* **29:**139 with *Falkauer* #54. M = 15.3 on 27 June 1981.

21. **Markarian 478** (1440 +356). 14h40m05s, +35°39'08". z = 0.077. *Astrofizika* **8:**155 with *Atlas Stellarum* #81. M = 14.8 on 31 May 1989.

22. **Markarian 841** (1502 +106). 15h01m36s, +10°37'57". z = 0.036. *A.J.* **76:**683 and *Astrofizika* **12:**657 with *Atlas Stellarum* #182. M = 15.1 on 31 May 1989.

23. **AP Librae** (1514-241). 15h14m 45s, -24°11'20". z = 0.0486. Craine with *Falkauer* #290. M = 14.5 on 12 July 1980.

24. **Markarian 877** (1617 +175). 16h17m57s, +17°31'34". z = 0.114. *Astrofizika* **12:**657 with *Atlas Stellarum* #148. M = 15.1 on 5 August 1988.

25. **Markarian 501** (1652 +398). 16h52m12s, +39°50'. z = 0.0335. Craine with *Falkauer* #83. M = 13.9 or brighter on 5 July 1978; 13.9 on 8 August 1980.

26. **2155-304**. 21h55m58s, -30°27' 52". z = ? *ApJ Letts.* **229:**L53 with *Falkauer* #333. M = 14.3 on 8 August 1983.

27. **BL Lacertae** (2200+420). 22h 00m39s, +42°02'08". z = 0.070? Craine and *Astro. & Astrophys.* **3:**437 and *ApJ Letts.* **212:**L47 with *Falkauer* #89. M = 14.4 on 8 August 1980.

Todd Hansen has been an enthusiastic observer of quasars for several years. He lives in Potter Valley, California.

Deep Sky Reports

Revisiting the Australian Sketchbook

by Gerd Bahr-Vollrath

The Keyhole Nebula, central portion of the Eta Carinae Nebula, shows in this sketch made with an 8-inch f/10 SCT at 230x and a UHC filter.

Left: The peculiar galaxy NGC 5128 is easily visible as a twin-lobed object at 155x in the 8-inch f/10 SCT. All sketches in this article are by Gerd Bahr-Vollrath.

Since my last article in the Spring 1990 issue, I have kept myself busy observing and sketching. Once again I would like to show you northerners some gems of the southern skies. In *Deep Sky*, I recently read with much interest about observing and identifying members of challenging galaxy clusters, and I would like to point out two interesting clusters for southern observers. One is the chain of galaxies around the giant elliptical NGC 3311 in Hydra. I was able to count five faint galaxies in the 35' field of view my binoculars offer. Checking the catalogs, I found out that the area is literally filled with galaxies fainter than magnitude 12.5. Large scope owners should find this field to be a rewarding hunting ground.

Another challenge for medium aperture telescopes is a group of galaxies in Antila around NGC 3268. This time I was able to detect six members as ill-defined faint glows. As with the group in Hydra, I plotted the galaxies just as round glows — my 8-incher could not reveal any other structure.

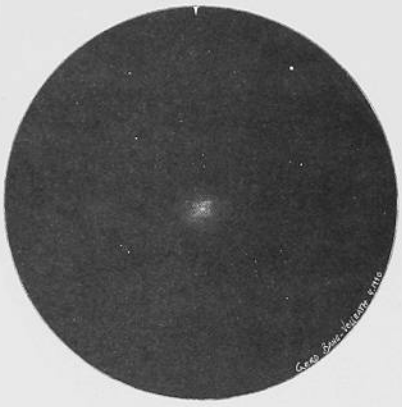
In the heart of the constellation Corvus you'll find the planetary nebula NGC 4361. It appears to have a very unusual shape. A bright, diamond-shaped central part is surrounded by a faint envelope. I thought I saw the central star, which glows at magnitude 13.4. As with most planetary nebulae, a UHC filter greatly enhanced the view.

NGC 4038-9, the Ringtail Galaxy, also lies in Corvus and display two mottled oval bodies that are almost touching each other. The peculiar streamers of stars that emerge from this colliding pair were not visible. It seems that only a good photograph can reveal this interesting feature. I would be very curious to find out whether anyone has seen this galaxy's faint, antenna-like extensions.

M104 lies close by and requires little explanation. The 8-inch scope clearly revealed the slightly curved bisecting dust lane, but the famous Sombrero hub only occasionally popped up using averted vision. If there were a beauty contest among galaxies, M104 would certainly be among the runners-up.

Heading toward the southern Milky Way, you'll cross the constellation Centaurus and invariably end up looking at NGC 5139, Omega Centauri. Catalogued as a class 8 globular cluster, Omega does not show such a dynamically compressed core as 47 Tucanae or M13, but the sheer extent of this object is awesome. To give you an idea, the field of view in my sketch is 35'. Photographically, Omega Centauri spans about 1°. While you are in the area, you must stop over at NGC 5128 and NGC 4945. NGC 5128 is a peculiar galaxy that recently sported a bright supernova. The 8-incher showed the bisecting dust lane easily, and averted vision reveled some mottled structure along the edges of the dust lane. NGC 4945 is an almost edge-on spiral galaxy that resembles very much an old fashioned cigar. Here, too, mottled structure was very evident.

The ultimate show-stopper in the whole sky is most likely NGC 3372, the famous Eta Carinae Nebula. This object also contains the dark nebula called the Keyhole. When I look at the



Top right: Edge-on galaxy NGC 4945 in Centaurus is a sparkling streak of light in this view made with the 8-inch f/10 SCT at 63x.

Right: A photograph of the galaxy shows an extremely similar appearance. Photo by Jim Barclay (12.5-inch f/6 reflector, VR 1000 film, 45-minute exposure).

Top: The complex of nebulosity known as RCW 57 makes a pretty field in the 8-inch f/10 SCT at 63x.

Above: Planetary nebula NGC 4361 in Corvus shows central detail at 155x when viewed with the 8-inch f/10 SCT.

whole extent of Eta Carinae with an f/6.5 telecompressor and a 20mm Nagler, I can see just about as much nebulosity as a good photograph can reveal. The brighter zones cover about 1.5°, and faint streamers can be traced much further. The overall shape of Eta Carinae reminds me of an outline of a royal coat of arms, a very appropriate comparison. I could not resist making two sketches on Eta Carinae. One gives a 55' field of view and shows the brighter parts. The other zooms into the Keyhole and shows you detail in this area.

The brightest star near the keyhole is the erratic variable star Eta Carinae itself, which is enveloped in a small shell of nebulosity dubbed the Humunculus Nebula. A high power view of the Humunculus under steady seeing reveals a figure-8 glowing in the orange color of its parent star. A UHC filter helped tremendously to view the Eta Carinae Nebula, as it would have been difficult at times to separate the outer faint filaments from the background glow of the rich southern Milky Way.

Heading toward Crux, the Southern Cross, we encounter a beautiful, but neglected, region of nebulosity RCW 57. Musca is one of the less conspicuous constellations surrounding the South Celestial Pole. I was surprised to find one of the most appealing planetary nebulae I have seen yet in NGC 5189. It appears like an elongated "S" with numerous knots. Like NGC 6302, the Bug Nebula, NGC 5189 is a striking example for a bipolar planetary.

Top left: The Ring-tail Galaxy, NGC 4038-9, is one of Corvus' prettiest sights. This sketch was made with the 8-inch f/10 SCT at 155x.

Left: A photograph of the Ring-tail Galaxy shows the intricate, low surface brightness detail in the galaxy's inner regions. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 60-minute exposure).

Top: Shapley 1 is a perfectly round planetary, as shown by this drawing made with the 8-inch f/10 SCT at 155x.

Above: The galaxy cluster containing NGC 3308, NGC 3309, NGC 3311, NGC 3312, and NGC 3314 fills the eyepiece in the 8-inch f/10 SCT at 80x.

NGC 6188-93 is a large area of nebulosity associated with an open cluster in Scorpius. Photographically it resembles the Cone Nebula in structure, showing sharply defined dark lanes. Visually it is a bit less impressive. With a UHC filter at low powers I could make out some structure. The nebula spans a vast area, to my estimate at least 1° across. Whenever I next have the opportunity to use a large scope, NGC 6188 will be on my list.

Using very low powers and a UHC filter, I was able to detect the prominent shape of the Lagoon Nebula (M8). With medium powers and no filter, all I can usually see are the brighter sections around the dust lane. It certainly pays off to have an eyepiece with a large exit-pupil. The photographically evident Bok Globules did not show up.

To end this tour of the southern skies, I would like to present three perfectly ring-shaped planetary nebulae: Shapley 1, PK 329-2.2, and NGC 6337. All three were readily visible in my 8-inch SCT, although Shapley 1 is listed at magnitude 13.6, which I found to be unlikely. I cannot describe the thrill when I first saw these perfect shells of nebulosity. I wonder how such perfectly symmetrical objects can emerge out of a supposedly chaotic universe?

Gerd Bahr-Vollrath has been sketching southern sky objects from his native Australia for several years. This is his second contribution to Deep Sky.

Telescopes & Accessories from
Wholesale Optics of Pennsylvania
Tele-Vue "TOPS IN THE FIELD"

Genesis for 1991!
For the most impressive views of Star Clusters and Nebulae, for startling sharpness in viewing the moon and planets — the 4 element Genesis with fluorite lens and 101MM clear aperture is the instrument of choice, in stock for immediate delivery!

Sale prices on all Tele-Vue eyepieces and accessories.
Treat yourself to the finest Plossls, Widefields and Naglers — absolutely the best and all in stock at sale prices for 1991.
New "Starbeam" Piggy cam and Tele Pod available

TELRAD
w/Base
and free batteries
$39.00
Extra Bases $7.95
Hinged Deluxe Dew Caps . . . $10.00
Extra Reticles $2.95

QUARTZ DRIVE CORRECTORS BY VOGEL — ALL DIGITRAK II

SINGLE AXIS		DUAL AXIS	
VE-200 Runs off DC	$132.95	VE-200 D	$174.95
VE-300 Runs off DC/AC	$159.95	VE-300 D	$212.95
VE-400 Runs off DC/AC or Int. Battery	$198.95	VE-400 D	$262.95
		VE-100 Inverter (converts your motor to DC)	$71.95

PORTA-PAC
$65.00
12 AMP HR. Heavy Duty
PORTA PAC $86.95

THOUSAND OAKS SOLAR FILTERS *THE BEST!*
Get ready for 1991's Solar Eclipse and Continued High Solar Activity!

Type I 8"	$84.95	Type I 10"	$94.95
Type II 8"	$114.95	Type II 10"	$124.95

All sizes available for all scopes. Type III for photography now avail.

SOLVE FOCUS PROBLEMS FOREVER
with Spectra's Sure-Sharp Optical Grid Focusing method for perfectly focused astrophotos. **$129.00**
Right Angle Viewer $44.50. All acc. available

Tectron Collimators improve Newt. images w/the following

Sight Tube	$29.00	*Fast Scope Owners!*	
Cheshire Eyep	$38.00	Ultra Low Rack	
Auto-collimator	$31.00	& Pinion Focusers	
Above 3 w/Bklt	$95.00	2" w/11/4" Adpt.	$125.00
Bklt. only	$5.00	Photographic Focuser	$159.00

JIM'S MOBILE

Moto-Focus LX3/5/6	$78.00
Moto-Decs LX3/5/6	$75.00
NGC MAX/DSC-MAX/ SGT MAX	Call

New "MINI MAX" Now Avail.
Electronic Focusers & Decs for all Scopes

EDMUND SCIENTIFIC
Astroscan 2001
"The go anywhere scope"
41/4" Portable Reflector Scope
$282.00
All Accessories Avail.

B&L 8x50 FINDER
St. thru $46.95
BKTS. Spec. SCT or Newt. **$28.00**
5x24 Rt. Angle $37.95
6x30 Rt. Angle $42.95
Bracket $18.00

BINOCULAR SALE
We carry Zeiss • Fujinon • Swarovski • Steiner • Nikon • Swift • Celestron • Meade • Kowa • B&L
Contact us for prices!

BOOKS & STAR CHARTS

MAG 6 Star Atlas	$15.95	Sky Atlas 2000–Field or Desk	$16.95
Uranometria Vol. I or II	$39.95	Sky Atlas 2000–Color	$39.95
1000 Plus	$39.95	Laminated 2000 Field or Desk	$58.95
Laminated Deluxe Color	$78.95	Burnham's Celestial Handbook, All 3	
Norton's Star Atlas	$34.95	Volumes	$35.85

We carry a full line of astronomical books & publications

"ACCESSORY CORNER"

T-Rings	$10.00	12.5MM Wireless III. Reticle	$95.00
Tele-Extenders for SCT's	$22.00	Meade 7MM R. Gr. Ortho	$45.95
T-Adapters for SCT's	$20.00	11/4" 32MM Erfle	$50.00
New Deluxe Optics Cleaning Kit	$19.95	B&L Pro Plossl 26MM	$49.95 ea.
Set of 6 Color Filters 1.25"	$59.95	18 or 25MM 2" Celestron Ortho	$74.95
Drives for Tasco Eq. Mount	$89.95	Sale on Meade/Celestron/University/ TeleVue and Brandon Eyepieces!	
Anit-Vibration Pads for Tripods	$45.00	All the Major Manufacturers Scopes and Accessories at Recession Fighting Prices!	
Tri Pod Slo-Mo Controls	$46.00		

EDMUND SCIENTIFIC

11/4" RKE 8, 12, 15, 21 or 28MM	$38.95
RKE 2.5X Barlow	$59.95
11/4" Orthos 4, 6, 12.5, 18 or 25MM	$49.95
Ortho Zoom 8.4-21MM	$91.95
11/4" Kellners, 6, 9, 12, 18 or 25MM	$32.95
11/4" Erfle 20MM	$49.95
2" 32MM Wide Field Erfle	$119.00

ALL EDMUND PRODUCTS AVAILABLE

ULTIMA 8/11 PEC. • MEADE SMART PREM. CATS AVAIL./GIFT CERTIFICATES AVAILABLE

MEADE • CELESTRON • TELE VUE • B&L • BRANDON • PARKS • EDMUND • UNIVERSITY OPTICS • JMI • THOUSAND OAK FILTERS • QUESTAR

Wholesale Optics of Pennsylvania
North Pocono Village Shopping Center
RR 6, Box 6329, Moscow, PA 18444
Speak with amateur astronomers
Ask for Glenn-ARS, K3WEI

Call till 9 PM: (717) 842-1500
FAX 717-842-1408 24 hrs.
P. List send SASE
3% Cr. Cg. Cat. $3.00

WORLDWIDE SHIPPING
$5.00 MIN.
SHIPPING IN U.S.

HYPERSENSITIZED FILM!

2415 Fine Grain, B&W Hypered
15Exp. – $5.95
2415 Fine Grain, B&W Hypered
24Exp. – $6.95
2415 Fine Grain, B&W Hypered
36Exp. – $8.95

WINTER SPECIAL

Stock up for the spring
30% SAVINGS
10 rolls of 2415 Hypered
15 Exp. – Only $40.00
$2.50 shipping & handling

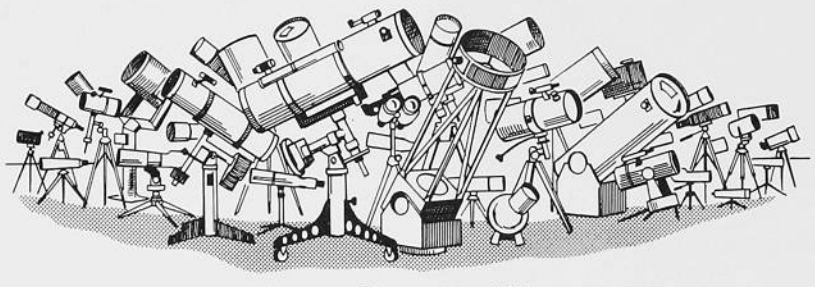
COLOR PROCESSING SPECIAL

Develop and Print 3 1/2 x 5 Prints
Doubles – $8.15
24 Exp. – $5.99 (Doubles – $8.15)
36 Exp. – $7.99 (Doubles – $11.25)
For 4 x 6 prints add $2.00 onto these rolls.

Custom Darkroom Services

Send check or money order.
MasterCard and Visa accepted.
Shipping & Handling add $1.25.
(CA res. add 6.5% sales tax.)

G.M.R.
Custom Photographic Lab
700 Cass, #106, Monterey, CA 93940
(408) 373-8021



Twenty bucks will get you $1,000,000 worth of telescopes

That's how many telescopes are for sale each year in *The Starry Messenger*, the nation's oldest and largest classified shopper devoted solely to telescopes, eyepieces and accessories for astronomy.

No better way to buy or sell

Every month we print classified ads for Astro-Physics refractors, TeleVue eyepieces, Coulter Dobsonians, Meade & Celestron SCTs - you name it - all at swap table prices. Need magazine back issues? ATM supplies? Star charts? A drive corrector? *The Starry Messenger* classified shopper has whatever you're looking for.

And no wonder. After all, *more amateur astronomers sell their telescopes and accessories through TSM than anywhere else.* Doesn't it make sense to check *The Starry Messenger* first?

Sell your telescope - guaranteed

Send no money - just your advertisement. If your ad doesn't sell, we'll keep running it until you find a buyer. When your ad is successful and you've made your sale, you simply pay a 4% commission. A *Starry Messenger* classified ad will turn your telescope into cash fast - in as little as 2 weeks!

Subscribe without risk

Send us $20 ($25 in Canada) and we'll send you a million dollars worth of telescopes in twelve monthly issues. And if you don't save $20 the first time you buy something we'll refund the unused portion. So write us or call today - don't miss another ad-packed issue!

The Starry Messenger
PO Box 6552-D, Ithaca, NY 14851
(201) 992-6865 (24 hours)

VersAgonal™

- All-In-One Accessory for SCTs & Refractors
- 2 Inch Star Diagonal
- Off-Axis Guider
- Eyepiece / Camera Instantly Selectable
- Built-In Barlow and Telecompressor

DiaGuider™

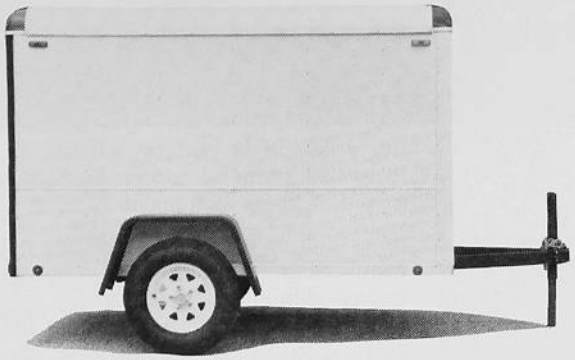
- Fully Adjustable Off-Axis Guider
- Eyepiece / Camera Instantly Selectable
- 1¼ Inch Star Diagonal
- Optional Filter Drawer and Manual "Shutter"
- *Affordable -- from $195.*

SEND $1.00 FOR CATALOG

VERSACORP
P.O. Box 7, Sun City, AZ 85372
(602) 972-1878

FULL LINE DEALER FOR VERNONSCOPE AND QUESTAR

"With a Wells Cargo Behind . . . You Never Look Back"



WHY REPACK EVERYTHING...EVERYTIME YOU HEAD FOR DARK SKY?

One observer we read about packs chairs, cots, coffee pot and heater, too in his Wells Cargo. He's ready to roll. About the only thing left to load is his telescope. That kind of storage and transport means the family car is no longer a repeated load...unload proposition. The cost is less than you think. Call today, and find out.

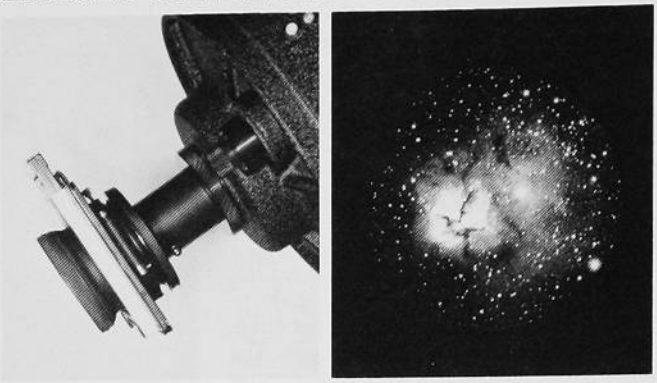
- **Factory Service Facilities - GA, IN, TX, UT.**
- **US Wide Dealer & Service Network.**
- **Second-to-None 3 Yr. Warranty Coverage.**
- **Full Line Ball-Hitch Units 6' — 32' and Up.**
- **Full Line Fifth Wheel Units 20' — 40' and Up.**

CATALOGS • PRICES • DEALERS
4 PLANT LOCATIONS
CALL 1-800-348-7553
TELL US YOU SAW IT IN DEEP SKY

WELLS CARGO **WELLS CARGO** **SINCE 1954**

P.O. Box 728-991 **ELKHART, IN 46515-0728**

LARGE FORMAT ASTROPHOTOGRAPHY



SKY SCIENTIFIC ASTROCAMERA MODEL C45
uses conventional 4x5 inch sheet films for professional quality photographic results. Features 2.0" O.D. Barrel Mount, 3.0" near focal plane low vibration leaf shutter, ground glass focusing. For telescopes that accept two-inch accessories.....**$295**
OPTIONS: Chilled 4x5 Film Back for cold camera astrophotography.....**$300**
Polaroid Pack FIlm Back for INSTANT astrophotos with films speeds up to ISO 20,000.....**$100**

Add $3.50 insurance/shipping/handling in USA. CA residents add 6.75% sales tax. VISA/MasterCard accepted. Send $1.00 for our new illustrated catalog.

SKY SCIENTIFIC
28578 Hwy 18, B-184 • Skyforest,Ca.92385
(714) 337-3440

DEEP SKY BACK ISSUES

The Wonders of Deep Sky Await You!

Here's your chance to complete your collection of DEEP SKY! Limited quantities of DEEP SKY are available. In DEEP SKY you'll discover articles on equipment, observing, and astrophotography techniques plus handy maps, observing aids, and sketches. DEEP SKY back issues are available for $3 each. Make your selections and order

DEEP SKY 7
Deep Sky Objects in Cygnus the Swan, Ophiuchus' Magnificent Globular Clusters, Observing Cepheids in M5

DEEP SKY 8
All About M31, the Andromeda Galaxy, Choosing Film for Astrophotography, Cassiopeia's Bright Open Clusters

DEEP SKY 10
Sketching Details in Galaxies, Observing Galaxy Clusters in Leo and Coma Berenices, Deep-Sky Objects in Centaurus

DEEP SKY 13
The Bright Star Clusters of Canis Major, Deep-Sky Objects in Auriga and Gemini, How to Photograph Star Cluster

DEEP SKY 14
Deep Sky Objects Along Halley's Path, Visiting Lowell Observatory, The IC 4329 Galaxy Group

DEEP SKY 15
Summer's Multitude of Planetaries, The Central Stars of Planetary Nebulae, Observing Planetaries from the City

DS Fall 1986 16
The Double Cluster in Perseus, NGC 7331 and Its Ambiguous Galaxies, Summer Convention Report

DS Fall 1987 20
Autumn's Bright Planetary Nebulae, Wonders of the Deep North, Stellafane 1987

DS Winter 1987 21
Taking Your First Piggyback Astrophotography, Treasures of the Unicorn, Outbursts of FU Orionis Stars

DS Summer 1988 23
M7 and Its Planetaries, Hints for Prime-Focus Photography, Deep-Sky Wonders in Ophiuchus, Serpens, Scutum

DS Fall 1988 24
Off-Season Globular Clusters, Schmidt Camera Photography, A Special Report on the Texas Star Party

DS Winter 1988 25
Star Clusters of the Winter Milky Way, Exploring Taurus, Films and Filters of Astrophotography

DS Spring 1989 26
A survey of Bright Globular Clusters for Backyard Telescopes, Tracking Down the NGC 4005 Group, A Trio of Springtime Galaxy Clusters

DS Summer 1989 27
Galaxies and Other Deep-Sky Objects of Lyra, A Night of Galaxies Near M13, Hypersensitizing Kodak Technical Pan 2415

DS Autumn 1989 28
Observing the Morphology of Galaxies, the Uppsala General Catalogue and its Place in History, Observing Variable Stars from Down Under

DS Winter 1989 29
Galaxies Near the Winter Milky Way, Observing Nearby Stars, The Rise of Deep-Sky Observing

DS Spring 1990 30
Simulating Face-on Galaxies, Treasures of the Southern Cross, Prime Focus Astrophotography

DS Summer 1990 31
Wide Field Astrophotography, Galaxies along the Summer Milky Way, The Search for Supernovae

DS Autumn 1990 32
The Deep-Sky Wonders of Pegasus, Meet the New Generation of Astrophotgraphers, Observe Globulars in the Andromeda Galaxy

DS Winter 1990 33
Observing the Tombaugh Clusters, How to Sketch Planetary Nebulae, The 1990 Texas Star Party, Lacerta's Mysterious Star Clusters

Yes! Send me the DEEP SKY back issues I have checked at $3 each.

Enclosed is $_____

- ❑ DEEP SKY 7
- ❑ DEEP SKY 8
- ❑ DEEP SKY 10
- ❑ DEEP SKY 13
- ❑ DEEP SKY 14
- ❑ DEEP SKY 15
- ❑ DS Fall 1986 16
- ❑ DS Fall 1987 20
- ❑ DS Winter 1987 21
- ❑ DS Summer 1988 23
- ❑ DS Fall 1988 24
- ❑ DS Winter 1988 25
- ❑ DS Spring 1989 26
- ❑ DS Summer 1989 27
- ❑ DS Spring 1990 30
- ❑ DS Summer 1990 31

Name _____

Address _____

City, State, Zip _____

Send this coupon or a copy to: DEEP SKY Order Dept. DK031, P.O. Box 1612, Waukesha, WI 53187-1612. Include for postage and handling: U.S. $3.00; Canadian and foreign add 18% (minimum $4.00). Canadian Orders add 7% GST to total. Payable in U.S. funds only. Wisconsin residents add 5% sales tax. Prices and availabilty subject to change.

Dept. DK031

Deep Sky Reports

Spring's Challenging Deep-Sky Objects

by Phil Harrington

In the winter issue of *Deep Sky*, I devoted this column to challenging deep-sky objects for binoculars. This time, it's only fair to cater to telescopes. The springtime night sky offers a greater number of faint test objects than any other season. Galaxies as far as the eye and the telescope can see dot the heavens. The following are but a select few to whet your appetite.

4-inch to 6-inch scopes: NGC 5005

R.A. 13h10.9m, Dec. +37°03′ Constellation: Canes Venatici Magnitude: 9.8 Size: 5.4′x2.7′ Galaxy

Nestled near a slim triangle of 6th- and 7th-magnitude stars just 3° southeast of Cor Caroli (Alpha Canum Venaticorum) is the amazing little galaxy NGC 5005. Classified as an edge-on Sb spiral, NGC 5005 appears as a 10th-magnitude splinter of grayish light through 4- to 6-inch telescopes. While *Sky Catalogue 2000.0* lists its dimensions as 5.4' by 2.7', in the telescope it appears to be 4' by 1' in extent. Under good sky conditions, this galaxy's nucleus appears distinctly circular and wider than the flattened spiral arms. Your best view of this neat little beauty will come with medium to high power.

8-inch to 10-inch scopes: NGC 5053

R.A. 13h16.4m, Dec. +17°42′ Con.: Coma Berenices Mag.: 9.8 Size: 10.5′ Globular Cluster

Galaxies aren't the only challenging objects in the spring sky. Coma Berenices is home to one of the most elusive globular clusters visible in backyard scopes. Although it glows at 10th magnitude, NGC 5053 frequently eludes observers using 8- to 10-inch telescopes because of its low contrast against the background sky.

The cluster's lackluster appearance stems from its poor concentration of stars. NGC 5053 shines with a light equivalent to 16,000 suns; typically, a globular cluster's luminosity is ten times that or more. This absence of a dense central core results in an extremely dim image. Resolution of some of the individual stellar members may only be suspected through large amateur telescopes.

12-inch to 14-inch scopes: The NGC 4319 Galaxy Group

NGC 4291: R.A. 12h20.3m, Dec. +75°22′ Con.: Draco Mag.: 12.2p Size: 2.2′x1.9′ Galaxy

NGC 4319: R.A. 12h21.7m, Dec. +75°19′ Con.: Draco Mag.: 12.2p Size: 3.1′x2.5′ Galaxy

Markarian 205: R.A. 12h21.7m, Dec. +75°18′ Con.: Draco Mag.: 14.5 Size: stellar Quasar

NGC 4386: R.A. 12h24.5m, Dec. +75°32′ Con.: Draco Mag.: 12.4p Size: 3.0′x1.7′ Galaxy

"Three 12th-magnitude galaxies? Not much of a challenge for a 12-incher! — Harrington must be getting rusty." Spotting detail in these objects is quite a challenge, however. I first

Three members of the NGC 4319 galaxy group are visible in this photo. NGC 4319 lies at upper right, and the quasar Markarian 205 immediately above and left of the galaxy's nucleus. NGC 4291 lies below NGC 4319, and NGC 4386 to the right. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 55-minute exposure).

bumped into this clump of three galaxies six years ago on a clear Vermont night at Stellafane. Through my 8-inch f/7 reflector, all three were faintly visible as small glows.

Although it was pretty much a coin toss for the winner, NGC 4291 impressed me as the brightest galaxy of the three. Rated at photographic magnitude 12.2, this E1 elliptical appears ever-so-slightly oval with its 2.2' by 1.9' dimensions. A stellar nucleus, while not noticed in the 8-inch, is evident in larger scopes. NGC 4386 seemed to be the largest of the three, despite published statistics to the contrary. A homogeneous, oval glow is all the 8-inch scope revealed, but larger instruments will add a little more detail, especially at medium-to-high power. I recorded NGC 4319 as the faintest of the three galaxies. An SBb-barred spiral, it was seen through the 8-inch as just a stubby ellipse of gray light.

Now take a second look at NGC 4319. Do you see a faint, starlike point about 42" to the galaxy's southeast? That is Markarian 205, a quasar. In long-exposure photographs, galaxy and quasar appear to be physically linked by a luminous bridge of material. How can that be? NGC 4319 — and the other galaxies here — have relatively small redshifts corresponding to an average distance of about 120 million light-years. Markarian 205 has a redshift eleven times as great!

Most professional astronomers are sticking to their guns that big redshifts beget big distances. If so, then the association of NGC 4319 and Markarian 205 is only line-of-sight, not real. Others, such as maverick astronomer Halton Arp, argue that the association is real and that our current physics is wrong. They point out that there are far too many close galaxy/quasar combinations across the sky to dismiss all as merely coincidences.

Only time will tell which camp is right. However, thanks to today's large-aperture backyard telescopes, you and I both have ringside seats to this cosmological fight. Pass the peanuts.

16-inch and larger scopes: Tough Virgo Galaxies

IC 4217: R.A. 13h17.2m, Dec. -13°09′ Con.: Virgo Mag.: 15p Size: 0.6′ Galaxy

NGC 5072: R.A. 13h19.1m, Dec. -12°32′ Con.: Virgo Mag.: 14p Size: ? Galaxy

NGC 5070: R.A. 13h19.2m, Dec. -12°29′ Con.: Virgo Mag.: 15p Size: ? Galaxy

NGC 5076: R.A. 13h19.4m, Dec. -12°45′ Con.: Virgo Mag.: 13p Size: ? Galaxy

Galaxy NGC 5005 is visible in this photo by Lee C. Coombs (10-inch f/5 reflector, 103a-O film, 15-minute exposure).

NGC 5077: R.A. 13h19.5m, Dec. -12°39′ Con.: Virgo Mag.: 11.5 Size: 2′ Galaxy

NGC 5079: R.A. 13h19.6m, Dec. -12°42′ Con.: Virgo Mag.: 12p Size: 1.7′ Galaxy

NGC 5088: R.A. 13h20.3m, Dec. -12°34′ Con.: Virgo Mag.: 13p Size: 2.7′ Galaxy

NGC 5097: R.A. 13h20.9m, Dec. -12°29′ Con.: Virgo Mag.: ? Size: ? Galaxy

NGC 5099: R.A. 13h21.3m, Dec. -13°04′ Con.: Virgo Mag.: ? Size: ? Galaxy

NGC 5105: R.A. 13h21.8m, Dec. -13°13′ Con.: Virgo Mag.: 13p Size: 2.6′ Galaxy

NGC 5110: R.A. 13h22.5m, Dec. -13°05′ Con.: Virgo Mag.: ? Size: ? Galaxy

NGC 5111: R.A. 13h22.8m, Dec. -12°58′ Con.: Virgo Mag.: 13p Size: ? Galaxy

IC 884: R.A. 13h22.9m, Dec. -12°44′ Con.: Virgo Mag.: ? Size: ? Galaxy

NGC 5119: R.A. 13h23.9m, Dec. -12°17′ Con.: Virgo Mag.: 14p Size: ? Galaxy

IC 4235: R.A. 13h23.9m, Dec. -12°45′ Con.: Virgo Mag.: ? Size: ? Galaxy

Spica stands out as a jewel in a spring sky full of mostly faint stars. Less than 2° south of Spica, set around a small triangle of 7th- and 8th-magnitude stars, is a clump of galaxies boasting fifteen members in the NGC and IC catalogs. Studies are inconclusive, but it appears that all are outlying components of the Virgo cluster.

The brightest galaxy in the clump is NGC 5077, which lies less than 30' east of one of the triangle's 7th-magnitude stars. Glowing at magnitude 11.5, this E3 elliptical galaxy looks like a bright, oval patch of light highlighted by a bright, nonstellar core. NGC 5077 is the northernmost of three galaxies in a short string. To the south is NGC 5079, which can be spotted in 10-inch instruments under good skies as an oval, even patch of light. Just south of it is NGC 5076, the faintest of the three. It may be seen as a round smudge through 12.5-inch and larger instruments.

Moving northward, we encounter NGC 5070 and NGC 5072. Both lie only a few arcminutes south and west of comparatively bright field stars. The stars may aid in locating these faint galaxies, but they also hamper detection. NGC 5072 is brighter than NGC 5070 by about a full magnitude, but it is still a tough one to see. It impresses me as little more than a dim, nebulous smudge found just southwest of a 14th-magnitude star. (You know the galaxy must be faint when you're using a 14th-magnitude star as a reference!) Only the largest amateur scopes stand much chance with NGC 5070. The New General Catalogue calls it "extremely, extremely faint."

Situated northeast of NGC 5077, NGC 5088 glows dimly at photographic magnitude 13 and measures almost 3' across. A 12.5-inch telescope might just be able to pull in this low-surface-brightness Sc spiral on dark nights, but nearby NGC 5097 is another matter. Appearing nearly stellar except at high power, this object requires a 16-inch or larger instrument to reveal its faint presence. Look for this galaxy between two dim stars.

Scanning to the south and east of NGC 5077, we pick up an additional seven galaxies, including NGC 5099, NGC 5105, NGC 5110, NGC 5111, NGC 5119, and IC 884 and IC 4235. Of these, NGC 5105 and NGC 5111 are tied at photographic magnitude 13, while the rest shine at photographic magnitude 14 or dimmer. All require large instruments and optimum conditions to be seen. Observers also should note that only the NGC galaxies are shown on Uranometria 2000.0 (Volume 2, chart 285). The IC members were not included and must be plotted on your copy by hand.

Phil Harrington is an avid observer living in Smithtown, New York. He is the author of a book on binocular observing recently published by John Wiley & Sons.

Astrophotography by Barry Gordon, (Willmann-Bell, Inc., 1985), ISBN 0-943396-07-7, paperback, 206 pages, $18.95

In 1983, during a time when virtually no books on astrophotography were being produced by major publishers, New York amateur Barry Gordon took it upon himself to write and publish a book himself. *Astrophotography*, as it was aptly titled, showed of self-publishing by the dot matrix printout used for typesetting and a conspicuous scarcity of photographs. Willmann-Bell recognized the value of the manuscript and, in 1985, put out a second edition which is a tremendous improvement over the copy published by Gordon himself. This is in no way meant to demean the author's work. Self-publishing is time-consuming and expensive. As a result, many of the finished attributes so needed by books to sell were missing. Willmann-Bell improved upon the book's quality phenomenally by printing it on a heavy stock paper and adding plenty of photographs and illustrations.

Astrophotography was one of the first detailed books on the subject to appear in the modern era of celestial photography. Many old classics, which have been out of print for decades, are milestones in the field, but the outdated nature limits their usefulness.

The book covers all the topics you would expect, equipment — lenses, mounts, etc. — and techniques — prime focus, piggyback, constellation. But where *Astrophotography* stands out is the innovative fx system for exposure determination. Developed by the author, the fx system takes into account f/ratio, film speed, exposure time, and attenuation. All you have to do is make sure the sum of any three equals a fourth. Which ones? Well, it makes little difference — which is one of the beauties of the fx system. You can use the fx system to find the proper exposure time, or start with the desired exposure time and look for the appropriate f/ratio. The author provides fx values for numerous objects along with comparison of more familiar terrestrial scenes.

Gordon's strong background in mathematics shows throughout the text as he includes equations for everything from how much a star will trail for a given exposure to a mathematical explanation of the fx system. Those not comfortable with math can overlook these sections as it will not detract from the book significantly.

Top: An Air Force satellite view of the United States at night, taken in 1979, shows the state of light pollution in the U.S.

Above: A similar view of the world at night shows that many areas are dramatically affected by light pollution. Images courtesy Astronomical Society of the Pacific.

Many of the photos consist of David Healy's older work, which shows since recent introductions of new emulsions and darkroom techniques have helped to greatly improve the look of astrophotos. But in a sense, that is what Gordon wants to show — simple, unenhanced photos that the average photographer can take (with the right equipment, of course).

Even though the fx system is indisputably useful, I found it rather involved. For eyepiece projection (used primarily for solar, lunar and planetary photography), I use the equation that takes into account the focal ratio, film speed, and the relative brightness index of the object photographed. I find this formula much easier to use because it requires nothing more than a calculator with mathematical functions. For deep-sky photography, I have always looked at other photos to get an idea of the exposure time. Taking several photos of varying duration is really the only way to find the optimum exposure.

Furthermore, I was annoyed by the constant reference to the fx system

throughout the book. Aside from the initial explanation, numerous examples are repeated for each form of celestial photography.

Even though I don't find the fx system extremely useful, you may. The only way you'll know is to pick up a copy and try it yourself. And since the book contains a tremendous amount of information in addition to the fx system, its worth having.

Deep Time: The Journey of a Single Subatomic Particle from the Moment of Creation to the Death of the Universe and Beyond by David Darling, (Delacorte Press, 1989), ISBN 0-385-29757-2, hardcover, 192 pages, $17.95

Deep Time is one of the most unusual cosmology books I have ever read. Most other books approach the subject in the typical academic style, describing the formation of the universe from the outside. David Darling, the author of *Deep Time*, opted for a more poetic approach, writing it as a poetic prose. What further separates this book is its perspective. Here the origin, development, and ultimate fate of the universe is described from the perspective of a subatomic particle.

The book begins with the universe one second after formation, or "genesis" as the author refers to it. The author works backward to describe the formation of the various particles and forces and the origin of the universe. Once these fundamentals have been taken care of, the book proceeds on its course into time. And the journey is exciting indeed. During its trip the particle encounters several different events. On two separate occasions, it is almost swallowed by black holes before becoming part of a star which eventually undergoes a supernova explosion. It is during this phase that our particle becomes part of a gold atom which becomes part of a solar nebula that condenses to form a star with nine planets. As fate would have it, the gold atom, with the featured particle, winds up on the third planet from the star. Here it watches as life forms and eventually evolves into an intelligent race. This intelligent race then mines gold and our particle is made part of a spacecraft that is sent to explore the outer planets of this solar system. (Any of this sound familiar?) Once the job is complete, the spacecraft floats on into the void of space and it is from this vantage point we see the demise of the universe.

As interesting and fresh as this approach may be, I found it does not work completely — a fact that the author subconsciously acknowledges. The reason for this is that a great deal of the formation of the universe has to be viewed from outside by an observer who transcends all space and time. And on several occasions the author takes this point temporarily, leaving behind the limited view of the particle. As a result, the development of the universe is not seen from the perspective of the subatomic particle entirely. In addition, there are times where the author switches vantage points without telling the reader. I found this extremely frustrating as I tried to figure out the perspective.

This jumping around also happens at the beginning of the book. As mentioned previously, the book begins one second after the Big Bang and moves backward in time to the instant the universe formed to find out where it came from. However, along the way the author must sidetrack to explain the various types of particles and forces, along with their origin, making the journey difficult to follow. This information would have been better suited for an introductory chapter before the journey began.

One of the things I found most distressing is that the book does not live up to the author's promises. In the first chapter, Darling vows to give the reader a definitive explanation of the formation, development, and ultimate end of the universe — whether the reader agrees with it or not. Unfortunately, this is not true. The author, who obviously believes the universe is open, also draws out the fate of a closed universe — so much for the definitive explanation. In addition, the author criticizes other cosmology books for raising more questions than they answer. Yet, this book is no different. It too raises more questions than it answers, and for good reason; that is the nature of cosmology.

Overall, *Deep Time* is an excellent book, especially for those just learning about cosmology. There is a great deal of information here in an easy-to-read format. Just be aware of the limitations and don't take the author's introductory promises too seriously.

Light Pollution: Problems and Solutions Produced by The Astronomical Society of the Pacific, (1990), ASP publication number AS 294, booklet, 24 pages, 20 piece slide set, $24.95

Anyone who has been actively involved in amateur astronomy knows how bad light pollution has become — once dark sky observing sites are threatened by encroaching lights. In some instances, it's not just brighter skies, but light directly from the source that is becoming a problem. While many of us are annoyed by the problem, few of us know what can be done to curtail light pollution and preserve the skies we hold so dear. That is, until now. The new slide set and information booklet from the Astronomical Society of the Pacific are the perfect contrivance to learn about light pollution and educate others about it as well.

The booklet consists of three short articles and photo captions for the slide set. Norman Sperling penned the first article which is an overview of light pollution. Sperling outlines the threat light pollution poses to both the professional and amateur astronomical communities. The second article, by David Crawford and William Robinson, is an introduction to the slide set. This particular article gives specific suggestions on how light pollution can be reduced. The third article is an overview on lamps used to light nighttime scenes. It covers the various types of lamps used today with specifics on which ones are acceptable to astronomers.

Following the articles are the captions for each of the photos in the slide set. The captions are quite detailed, each running at least a paragraph. They illustrate and define the various types of light waste, such as light pollution and light trespass.

The booklet concludes with a short bibliography and information on contacting the International Dark-Sky Association, an organization devoted to increasing public awareness about light pollution. The only thing missing is information on how to lobby your local government body for better lighting ordinances.

Although the booklet is extremely informative, it would not be as useful without the slide set. Carefully selected photos clearly illustrate the problem with light pollution and how in has worsened over the years. For example, comparison night photographs of Los Angeles in 1908 and 1985 clearly show how increased population has directly, if not exponentially, affected light pollution. The 1908 photo shows L.A. as a tiny city surrounded by thousands of acres of undeveloped land. Seventy-seven years later, in 1985, L.A. is a sea of lights spilling over the horizontal boundaries of the frame. (That explains why I have to drive two hours to a moderately dark sky observing site, and three hours to an extremely dark site.)

The slide set not only shows how the problem has worsened, but also how, through proper lighting ordinances, the problem can be corrected. Comparison photos of the University of Arizona campus before and after light pollution ordinances went into effect dramatically show how the light pollution prob-

lem can be remedied.

Other slides include satellite photos of the United States and the entire Earth at night; good and bad security lighting; wasted light; light trespass; profile of lighted billboard. Such photos are real eye-openers as to the severity of light pollution.

For initial information on light pollution this new slide set and booklet are the ideal path. After that, get involved in the International Dark Sky Association. Taking these first steps may very well be important ones in preserving the night sky we love so much. And, with the environmental movement rightfully in full swing, now is the time for amateur astronomers to speak up about the type of pollution that, for the most part, goes unchecked.

Men, Monsters and the Modern Universe by George Lovi and Wil Tirion, (Willmann-Bell, Inc., 1989), ISBN 0-943396-24-7, hardcover, 112 pages, $24.95

Learning the constellations is not easy, a fact I learned in my early days as an amateur astronomer. One warm August night, I was in the mountains watching the Perseid meteor shower with several other amateur astronomers. As often happens, a bright meteor shot across a portion of the sky opposite the direction I was looking. When I turned to see what the others were yelling about, the meteor was no longer visible. When inquiring about the location of the meteor, only one amateur, who I will leave nameless, could identify the constellation through which the meteor passed and in the order it passed through them.

Why didn't everyone know the constellations as this one amateur did? Simple; learning the constellations is not as easy as trying to pick out mythological figures crudely outlined on contemporary star atlases. In fact, some recognizable star patterns, like the Big Dipper, are really asterisms and not entire constellations. Indeed, the Big Dipper is only the hind quarters and tail of Ursa Major, the Great Bear. To further complicate matters, many of the iconic figures are not accurately portrayed by the star arrangement — a point the authors of *Men, Monsters, and the Modern Universe* point out. And many constellations contain only faint stars. So how do you learn the constellations?

Men, Monsters and the Modern Universe provides a unique approach to learning by combing star atlases of old with the pictorial representations with new accurate charts. Broken down into two main sections, the book combines historical views of the skies with those of modern astronomy. The majority of the book consists of star pictures taken from the *Celestial Atlas* by Alexander Jamieson which was the last of the pictorial atlases. These plates alone serve as an invaluable tool in learning the constellations because they show the mythological figures relative to the actual stars within the constellations.

But aside from the plates, there is also text (directly opposite the plate) describing the plate itself, history behind the highlighted constellation(s), and astronomical (deep-sky) objects of interest. This portion of *Men, Monsters and the Modern Universe* is alone worth the price of the book.

The second section of the book, which comprises the last 32 pages, is the *Bright Star Atlas 2000.0* which is published separately by Willmann-Bell, Inc. (Since I reviewed this in the winter *Deep Sky*, I will not not repeat my comments here.) But the purpose in including this atlas is so the reader can perform a side-by-side comparison of the old with the new. The Jamieson plates are on the lefthand side while Tirion's charts are on the right. This way you can do side-by-side comparisons by lifting the pages in between the two charts. Each plate from Jamieson's atlas is cross referenced with the Tirion charts in the back of the book. The authors hope that a comparison of old and new skies will give the reader a better grasp of the constellations.

Although this method of learning the constellations is helpful, the cross-comparison of the two atlases is not that easy. First, the scale is not the same. This makes initial identification of some constellations a little tricky. In addition, the Jamieson plates are not oriented the same Tirion's charts, further complicating comparison. (North is to the left on the Jamieson plates while up on the Tirion charts.)

Some of the plates from Jamieson's atlas are difficult to read simply because they are so busy. This could have been counteracted by using multiple colored star maps, like the illustration on the cover (which would have most likely be accompanied by a substantial increase in the book's retail price).

I like the idea of comparing old with new, but the idea could be improved upon. Aside from the drawbacks mentioned above, I still like *Men, Monsters and the Modern Universe*. The Jamieson atlas with accompanying text is a real selling feature and I think most amateurs will find this information alone worthwhile.

Nearby Galaxies Catalog by R. Brent Tully, (Cambridge University Press, 1988), ISBN 0-521-35299-1, hardcover, 250 pages, $49.50 and *Nearby Galaxies Atlas* by R. Brent Tully and J. Richard Fisher (Cambridge University Press, 1987), ISBN 0-521-30136-X, cloth, 60 pages, $59.50

Any book with the words "catalog" or "atlas" in the title may, at first glance, appear to be observational in nature. But the *Nearby Galaxies Catalog and Atlas* are different. The purpose of this atlas and supplementary catalog is to define via maps the structure of the universe, or at least our immediate vicinity.

Since the book is not intended as an observing aid for amateur astronomers, the audience these two books appeals to is quite varied. First, the catalog. It begins with a short introduction and then dives into a detailed explanation of the individual column headings. What little text is here is of a very technical nature. The catalog, which is broken down into three parts, lists galaxies which have recessional velocities less than 3,000 kilometers per second. This low recessional velocity implies close proximity since popular theory suggests this directly relates to distance. The first portion of the catalog provides information on individual galaxies, some 2,367 in all, including name, coordinates (equatorial and galactic), morphological type, group affiliation, magnitude (blue and infrared), distance, etc.

The second part is a listing of group affiliation (i.e., Leo Cloud, Virgo Cluster, Centaurus Spur, etc.) while the third identifies rich galaxy clusters. This last section breaks with the aim of including only nearby galaxies. This volume is really for professional astronomers or very serious amateurs involved in research.

The atlas on the other hand is a publication which amateurs will find intriguing. The text, of which there is still relatively little, is written in a non-technical manner, making it more appealing to a general audience. But the real plus is the charts. Like the catalog, the atlas has three types of charts, each of which shows galaxy distribution differently. The first set of maps show the distribution of galaxies as they appear in the sky. Galaxies are color coded by recessional velocity while icons indicate type and size. Before you think this may be useful as an observing guide, consider this; the coordinate grids list galactic longitude and latitude, not equatorial.

The second set of charts shows a three dimensional distribution of galaxies while the third is a map of galaxy clusters.

The atlas is similar to Wil Tirion's *Sky Atlas 2000.0* in terms of layout.

Oversized pages fold open to reveal the attractive colored charts.

Ideally, the set is designed to go together since the catalog provides information on individual galaxies in the atlas. But because of the technical nature of the catalog, most amateurs will find it of little use. On the other hand, the atlas is much more appealing to amateurs. The colored maps illustrate the positions of thousands of galaxies relative to each other. Although this information in no way enhances viewing, it is stimulating information that gives amateurs a better perspective as to how the universe, at least our neighborhood, is laid out.

So, on some cloudy night when the telescope sits idle, the *Nearby Galaxies Atlas* would be a fun book to have around. It will put our neighborhood of the universe into a new perspective.

The Skywatcher's Handbook by Colin A. Ronan and Storm Dunlop, (Crown Publishers, 1989), ISBN 0-517-57326-1, paperback, 224 pages, $13.95

Initially, I was hesitant to include this book in the column simply because a good portion covers daytime observations. However, I have noticed that many amateur astronomers are sky watchers in general, not sole night sky observers.

As the title implies, this book is a guide to watching the sky. But not just the night sky. *The Skywatcher's Handbook* covers just about every natural phenomenon visible in the sky, both day and night. Aimed at the layman just learning about what's up there, this book covers both visual and photographic observations.

The book is broken down into three major sections. The first covers daytime observations, such as cloud types, lightening, rainbows, etc. The second covers observations of the night sky. It includes everything from aurorae to the zodiacal lights. It also includes 8 simple constellation charts showing stars down to fifth magnitude. The third and final section discusses specifics on photographing the phenomenon described in the first two sections.

The Skywatcher's Handbook is well written. Both the text and captions are short, yet quite informative. Keep in mind there is very little depth to each subject, but enough to get anyone started observing. The illustrations are so plentiful that there is at least one per topic. Aside from the shear number of photographs and drawings, they are excellent at showing the mechanism that produces each phenomenon and what you can expect to see. The illustrations alone are worth the price of the book.

The format is aesthetically pleasing and easy to use. No matter where you open the book, the two-page spread deals with one topic (although this topic may continue for several pages afterward). This layout makes the book easy to read and easy to find topics later when using it as a reference.

Although the book is very extensive in the number of topics it covers, there were a few important ones left out. Most notable was the absence of any mention of the green flash, one of my favorite atmospheric phenomenon.

There are also a few technical inaccuracies in the sections on observing and photographing the night sky. These errors are small — stating the Big Dipper is part of the constellation Ursa Minor — but nothing that seriously detracts from the book's usefulness.

Yet, with these slight drawbacks the book is still a welcome addition to any library. Even though the book is intended for someone just starting out, more advanced sky observers will find the book useful in teaching others about the sky, especially if they are looking for more concise ways to explain things.

The Stargazer's Companion by James K. Blum, (Mallard Press, 1990), ISBN 0-792-45262-3, hardcover, 144 pages, $19.95

A quick glance at this book, and I realized that this was one of the general observational astronomy books directed at the newcomer to astronomy — the kind that gives a cursory treatment to just about every topic in the field of astronomy. These books just have a certain look; the layout, the type of photos and illustrations used. They all look practically the same. And that's frustrating because when trying to draw outsiders into the field, there needs to be a fresh, original approach.

Furthermore, a disproportionately high percentage of these books are poorly written and researched, leading me to question the credentials of the authors. *The Stargazer's Companion* is just such a book.

As I do with most books, I looked this one over before I actually started reading it. The first thing I noticed was that the majority of the photos were provided by major observatories, telescope manufacturers, and government agencies (specifically NASA). In a book aimed at the neophyte stargazer, I look for photos and drawings made by amateurs which more adequately provide an indication of what the reader can expect to see for himself/herself. But that's not the case with this book. In the section on planetary viewing, all the photos were taken by spacecraft — nothing from an amateur telescope.

Photos used to illustrate the various types of telescopes and eyepieces were all provided by telescope manufacturers, giving the book the appearance of a commercial catalog, not an observing guide.

But the real problem with *The Stargazer's Companion* is in the text. Statements are misleading, confusing, and often false. For example, in the section on optics the author refers to eyepieces by magnification, not by focal length, as they should be. A side bar corrects this error and gives the correct formula for computing magnification. But, in that same side bar, the author states that a 4mm eyepiece used on a telescope with 2000mm of focal length produces a magnification of 250 times! Other eyepiece features, like barrel diameter, are not mentioned at all.

When discussing telescope types, terms are rarely defined. And when they are, the definitions are inadequate. Blum's outlandish observing statements make me wonder whether he has actually looked through a telescope. A caption for a photo of the Horsehead Nebula suggests that this is one of the most interesting objects telescopically. Try one of the most difficult! In the text on planetary observing the author states that amateurs using large telescopes can see the Great Dark Spot on Neptune!

Another surprise was Blum's acceptance of increasing space debris placed in Earth's orbit by the various space agencies of the world. His reason; it gives us more to look at.

Just when I thought the book couldn't get any worse, it did. Like many entry level books on observational astronomy, this one tries to explain some of the physics behind the objects mentioned. Once again, the author's explanations are way off track. While discussing novae and supernovae, the author uses the terms interchangeably, referring to SN1987A as both. In a last ditch attempt to clarify the discourse, the author states that novae are only seen at night while supernovae, being brighter, are seen in the daytime!

I could write a book about the problems with *The Stargazer's Companion*. About the only redeeming feature of the entire book is the extensive list of amateur observing groups, optics suppliers, publications, and planetariums. But that can be obtained in astronomy periodicals for a lot less money.

Despite what the title suggests, this book is definitely not a suitable companion when stargazing! If you're in the market for an entry level astronomy book, or know someone who is, try *Nightwatch* by Terence Dickinson.

Small Scope Showcase

Dwarf Galaxies for "Dwarf" Telescopes

by Alister Ling

The spring nights almost seem balmy in comparison to cold winter observing sessions. With the air at a few degrees above freezing, the gloves can come off once more. I always marvel at the simple reaction of the body to habit. In autumn, similar temperatures bring on a deep chill.

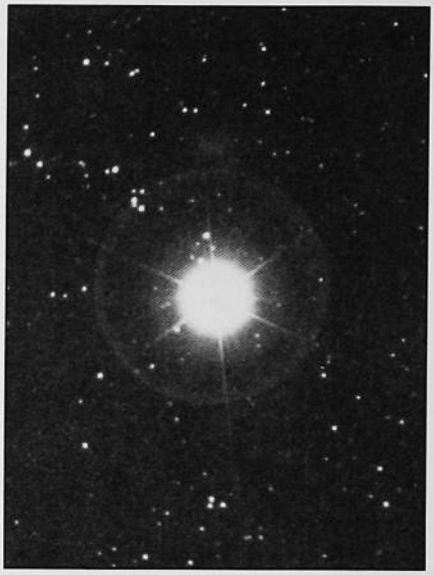
In a previous column I made the suggestion that small scopes can do useful and rewarding work supernova hunting. This is true even when the general transparency conditions are not very good. The main idea here is that the parent galaxy may be nearly invisible, but field stars and supernovae can shine through the light pollution and haze at medium to high powers.

What about the other extreme? A small scope functioning at low power can pick up very low surface brightness galaxies. E. E. Barnard taught us this when he made his discovery of NGC 6822 in Sagittarius with a 5-inch refractor back in 1884. Dwarf galaxies are quite the challenge for "dwarf" scopes. Instead of looking for spiral arms or dust lanes, we are aiming for simple detection. Over the years we have learned that we can experience quite a thrill from these feats of observational ability.

M33 (NGC 598) in Triangulum is the prototype large low surface brightness (LSB) galaxy. Readily visible in binoculars, it can get lost when you are trying to locate it with a decent aperture under less than ideal conditions. With this galaxy, and the next few which follow, contrast is the key parameter instead of aperture.

It pretty well goes without saying that the sky condition is the major factor in determining the visibility of LSB galaxies. Slight cirrus, haze, and aurora can kill the possibility. Before discounting any galaxy as invisible, you should give it a try on several occasions. You may with to wait until solar minimum to ensure the weakest auroral conditions if you live in the north.

Short refractors are definitely the best telescopes for LSB galaxy hunting. Their insides are well baffled, and together with their typically clean objective lenses keep scattered light to a minimum. This is critical for an object like the dwarf **Leo I**, just 20' north of Regulus. An open framework Newtonian has a tough time here since Regulus scatters light off dust, tube, and focuser, to name but a few sites. The trick is of course having a refractor big enough, but the 10' by 8' diffuse glow might well be within the grasp of a 5-incher. There simply aren't enough refractor owners who attempt deep-sky challenges for us to know.



Leo I is an extremely low surface brightness galaxy just north of the bright star Regulus. Photo by Martin C. Germano (5.5-inch f/1.65 Schmidt camera, hypered Tech Pan film, 5-minute exposure).

Left: NGC 2403 is a bright spiral that is easily visible in small scopes. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 60-minute exposure).

If Leo I is too much of a challenge, try **NGC 2403** or **IC 342** in Camelopardalis. Both of these galaxies have been reported in scopes as small as 6 inches. Your greatest challenge will be aiming your scope at the correct spot in space (*Sky Atlas 2000.0* is a great help). These two objects are well off the beaten path, but a nice sight to behold.

The Herschels can be forgiven for having missed IC 342. The sweeping power of the 18-inch reflector was 157x, giving a field of view of 15'. At a size of 18' by 17', IC 342 would have flowed out of the field! It certainly doesn't help that it is another magnitude fainter than NGC 2403.

No matter what the size of your scope, you should try to observe some H II regions in IC 342. These giant M42s or M17s might respond well to an O III filter. The galaxy will effectively disappear from sight, but perhaps a diffuse faint knot or two will remain visible.

Much easier to locate, but not necessarily as easy to see, is **NGC 4236**. This galaxy sits between the two tail stars of Draco, Kappa and Iota. NGC 4236 is a biggie, too — 19' by 7' and oriented almost north/south.

One of the observing techniques best suited for LSB objects is sweeping or rocking the scope back and forth over the charted position. The dark adapted eye is remarkable sensitive to the motion of subtle contrasts. At first all you may detect is that the background sky is somewhat brighter than the surrounding area. As your eyes dark adapt further, you may notice that the glow of NGC 4236 is not perfectly uniform.

The greatest challenge of this column's galaxies is the **Draco dwarf gal-**

NGC 4236 is one of the prettiest galaxies in the sky. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 75-minute exposure).

Left: Face-on IC 342 is a low surface brightness challenge. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 45-minute exposure).

axy. It can be found on *Uranometria* chart #52 not too far from the head of the dragon. It is a whopping 33' by 19' in extent, bigger than the Helical Nebula. Sweeping will be your best bet to detect this dwarf, coupled with properly adapted eyes that have not seen even a red flashlight for several minutes. The standard dark cloth hood will help even more. Don't give up too easily!

A big problem that often frustrates spring galaxy observers is dew. It especially strikes hard at the small scope owners. Although all telescope optics radiate thermal energy to space more or less equally, smaller optics contain less mass and therefore cool off faster. The nights are frequently loaded with moisture, which is quick to condense on lenses, mirrors, secondaries, and of course charts.

Dew does two things to the image. The most obvious effect is to create halos around the brighter stars, followed by the fainter ones as the condensation sets in. The second effect is to make everything fainter, not only by reducing the reflectivity, but also by scattering the available light around the field of view. Scattering is what creates the halos in the first place.

The gradual deterioration of the image can go unnoticed in spring because of the lack of bright field stars in galaxy territory to ring the alarm. Every galaxy begins to appear undefined at the edges. The light drop off at the edges of many galaxies is quite fast, but the scattering effect of the dew gives the edges, and especially the near-stellar cores of the galaxies, a rather "soft" appearance.

Further, the observer only gradually becomes aware that the magnitudes given seem a bit off — surely those 12th-magnitude objects are another unit fainter! The only way to prevent the night from being a short one is to set up heaters or keep a hair dryer handy. I've never liked hair dryers for two reasons. One is that they might spit some dirt specks out at the optics. But my main dislike is that I usually have to lose some dark adaptation with a brighter red flashlight to check if the dew is gone. This can be really frustrating if you are trying to push deep in galaxy clusters: After you've dried up the optics, the brighter galaxies are at first harder to see! If your scope is fairly small, you can't allow yourself the luxury of losing a magnitude.

Let's face it, we all struggle against the weather and time to get in some good observing, so we owe it to ourselves to use a couple of cloudy nights to wire up some heating units to make the spring nights as long as possible. Whether you're into marathoning for the Messier objects or excavating LSB galaxies, you'll need to be operational all night long!

Alister Ling is a Canadian deep-sky observer with wide expertise in nebular filters, planetary nebulae, galaxies, clusters, and small telescope observing.

Double Stars

A Survey of Cancer

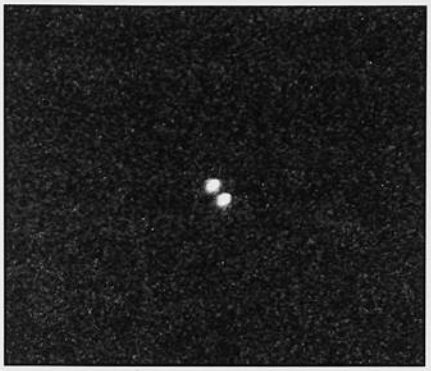
by Brian Skiff

This article continues the series examining all the brighter and more interesting pairs on a constellation-by-constellation basis. The targets were selected from the list in *Sky Catalogue 2000.0*, volume 2, by Hirshfeld and Sinnott. More recent data, particularly concerning the motions of the closer, rapidly-moving pairs, is gleaned from the professional literature. The present group of observations in Cancer was made while doing ordinary deep-sky observing of galaxies in the constellation. I find adding doubles to the observing list to be a way to add variety to a night's viewing, both in terms of extending the range of objects and because of the differing visual skills necessary to get the most out of viewing them.

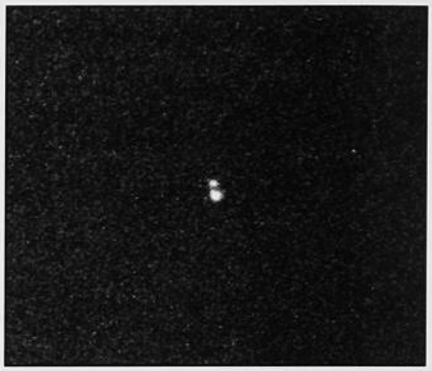
ADS 6499 is one of those really neat pairs I always talk about: roughly equal and about 2" apart. They were resolved but were very close together at 80x in my 6-inch refractor. At 165x I estimated the position angle as 100° or 105°, and the magnitude difference (Δm) as 0.3. You'll note in the table that the *WDS* lists the two stars as being equal. But that they are not was obvious; this observation is confirmed by Charles Worley in his recent USNO publication of micrometric measures, where his Δm estimates average 0.2 magnitude.

Beautifully isolated in a 50x/1.2° field is **ADS 6519**. At the wide end of my survey limits, it was well separated even at this low power. My estimates of p.a. 45° and Δm = 1.75 pretty well match the aging catalogue values. Pairs this wide really need measurement only once in ten or twenty years, but it's been nearly sixty years since this pair was measured accurately. Both stars are listed in the *AGK3* star catalogue, and the positions correspond to a separation of 10".6 in p.a. 53°, measured in 1959; a common proper motion is suggested. This indicates some motion has occurred, but another thirty years have passed since even that relatively coarse measure.

Much closer and better-studied is **ADS 6538**, a pair of bluish-white A-type stars. During twilight, with the seeing a little soft, I saw them slightly merged at 295x. Despite the relatively poor seeing, the p.a. (I estimated 80°) and Δm (0.4) were clearly discernable.



Phi^2 Cancri is a bright, equal pair. Photo by Brian Skiff (24-inch Clark refractor stopped-down to 16 inches, Kodachrome 200 film, 2-second exposure).



ADS 6569 is a bright, easy pair for small apertures. Photo by Brian Skiff (24-inch f/15 Clark refractor stopped-down to 16 inches, Kodachrome 200 film, 2-second exposure.

ADS 6569 is a bright-and-easy pair for moderate powers with small apertures. Even a 2.4-inch refractor should show this without difficulty. This pair was among the very first I observed upon starting to view doubles four years ago.

ADS 6612 (11 Cancri) has a bright primary but a faint companion. But by using 165x in twilight I found the companion without more than ordinary difficulty. According to the measures listed in the *WDS*, this pair has remained fixed since it was first measured by Struve in 1828.

Another easy pair is **ADS 6623**, which I could see just touching at 50x and nice-and-close at 80x. Using 165x I estimated a p.a. of 20°, and Δm = 1.0, fairly close to the most recent measurement. This pair is one of the widest to have been measured via speckle interferometry, a technique usually reserved for the closest doubles. Measures of wider pairs, however, provide a tie-in with measurements done by more traditional means, such as visual micrometry and photography to look for systematic effects.

The showpiece object in Cancer is **Zeta Cancri** (ADS 6650). The system consists of at least five stars, three of which are visible in amateur instruments. Because they are bright, the stars have been the subject of much study by professionals. Visible in the smallest telescopes is the wide, bright ABxC pair. Recent published measures of their separation are conflicting, but evidently they are rather closer than old orbits would predict, although the position angle is about right. Any orbit based on historical measures even as far back as Struve's first ones 160 years ago cannot really be reliable, since the period probably exceeds a thousand years, and only a small arc of the complete orbit has been observed. This is another one of those objects needing measurement about once every decade.

The C component is a triple. An extremely close companion was resolved during speckle observations, and the more distant third star reaches a maximum separation of only 0".2 during a 17-year orbit.

Of great visual interest is the primary AB pair. Because they are bright and nearly equal, they are frequently used by amateurs as a test of both seeing and telescope quality. Under perfect seeing conditions, they appear as a "breadloaf" in 6-inches aperture at 400x to 600x: the two Airy disks are significantly overlapped, but the image is lumpy, obviously not like a single star. Using the Lowell 24-inch Clark refractor and its iris diaphragm, it was possible to see the disks overlapping at 8-inches aperture, and then cleanly resolved when opened up to 10-inches and beyond.

Even though the pair have been observed over nearly three complete 60-year orbits, the elements are clearly not quite correct. The table lists speckle measures from the last several years made by Harold McAlister and colleagues. Compare these with the ephemeris from the most reliable orbit. The error in position angle is large

now, even though the predicted and observed separations match reasonably well. As the decade progresses, the observed measures will again match the prediction closely.

Why? Periastron of the system (closest approach of the stars in space, but not as viewed from Earth) occurred about 1990, but the speckle measures show the ephemeris is rather poor, with an error in position angle of 5° to 10° in recent years. The motion in position angle presently is rapid: the secondary star lies almost due south this spring, but before the turn of the century, it will have retrograded around to the east side of the primary, the position angle decreasing by over ten degrees every year — something you can detect visually very easily without special instruments. As the companion moves away from periastron, its motion will slow up (just as a comet does drawing away from the Sun), and the ephemeris error just mentioned will go away.

Phi² Cancri (ADS 6815) is a bright, wide pair comparable to the ABxC components of Zeta Cancri, and easy to spot at low power. Using 165x, I found the brightness difference just noticeable, perhaps less than 0.1 magnitude. The fainter star is to the southwest, in accord with the catalogue position angle.

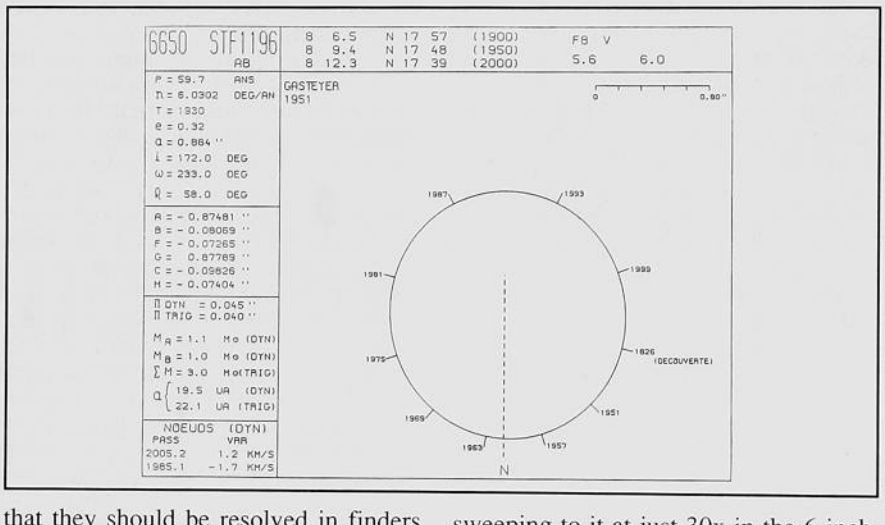
ADS 6886 lies just outside my separation limit for "interesting" pairs. But when I came upon it in the *SkyCat* double star list, I noticed three other companions listed with the pair. Upon actual observation, the bright pair was easy to see at 50x. The companions form a conspicuous right triangle about 2' across with the pair along the hypotenuse. But while the pair show a common proper motion of around 0".2 per year, the triangle stars are all optical companions unrelated to the binary.

Another very close pair is **ADS 6930**, which lies on the northeastern periphery of the Praesepe star cluster. The source of the difficulty is the magnitude difference between the components. In my survey of Cancer in the 6-inch refractor, I could not even see them as elongated. But using the Lowell Clark stopped to 10-inches, they were merely "difficult" at 630x, and the companion seemed very faint relative to the primary.

Iota Cancri (ADS 6988) is the spring sky's pale relative of Albireo: a very wide pair showing a notable color difference. In this case, the primary is a yellow giant and the fainter star a bluish A-type dwarf comparable to Vega. I think most of the color I saw was due to the contrast in brightness: the companion seemed too blue for its spectral type. The pair is wide enough

Double Stars in Cancer

ADS	Mags.	Sep.	P.A.	Date	Spec. type.	Notes
6499	8.5, 8.5	2.3"	105°	1980	F5	
6519	7.9, 9.6	10.0"	51°	1932	G0	
6538	7.5, 8.2	0.97"	74°	1988.3	A4 V	
6569	6.6, 7.5	3.5"	350°	1981	B9 V	
6612	6.9, 10.2	3.2"	218°	1960	G8 III-IV	= 11 Cancri
6623	7.1, 8.0	2.76"	26°	1985.8	F5 V	
6650AB	5.6, 6.0	0.60"	213°	1986.9	F8 V + G0 V	= Zeta Cancri
		0.59"	209°	1987.3		
		0.59"	198°	1988.3		
		0.59"	185°	1989.2		
ABxC	5.1, 6.2	5.57"	80°	1982	G0 V	
6815	6.3, 6.3	5.1"	217°	1973		= Phi² Cancri
6866AB	6.0, 7.3	10.3"	25°	1981	F6 + G5	
AC	10.7	93.2"	120°	1910		
AD	12.0	117.0"	282°	1910		
AE	8.8	122.4"	210°	1926		
6930	6.9, 8.4	0.47"	86°	1989.2	A0 III	
6978	9.6, 12.9	2.6"	72°	1938	F8	
6988	4.2, 6.6	30.4"	307°	1973	G8 IIIa + A3 V	= Iota Cancri
7071AB	6.0, 8.1	1.50"	313°	1986.9	G7 III + K0 (III)	= 57 Cancri
AC	9.2	55.6"	199°	1953		
7137	6.0, 8.1	4.5"	137°	1973	A2 V	
7187AB	7.0, 7.4	7.6"	200°	1973	F4 V + F5 V	
AC	12.6	27.8"	118°	1906		
7236	8.1, 8.6	1.8"	55°	1977	A4 IV	



that they should be resolved in finders and medium-power binoculars. In the field north-northeast of Iota Cancri is a faint pair, ADS 6978. In deep twilight I could just make out the companion at 165x.

A classic moderately close, bright double is **57 Cancri** (ADS 7071). I saw them barely elongated at 80x in the 6-inch, but clearly resolved at 165x. The distant third companion to the south is certainly fainter than the *WDS* magnitude indicates; my guess is more like magnitude 11 instead of 9. Can you confirm this?

66 Cancri (ADS 7137) is a fairly easy pair with a large magnitude difference. I estimated Δm to be about 3, much larger than the *WDS* magnitudes imply. A magnitude 11 field star northwest was visible at 80x, as was another similarly-bright star a little closer to the southeast, and a fourth very faint star closer still nearly due south. The bright pair has shown no motion since the first measure in 1831.

It was easy to spot **ADS 7187** while sweeping to it at just 30x in the 6-inch. At 80x and higher the magnitude 13 companion was visible to the east. My Δm estimate of 0.4 matches the *WDS* value — all is well with the magnitudes here!

Our final object is **ADS 7236**, off in the southwest corner of the constellation. They were recognizable at 80x, and well-separated at 165x. Here I estimated Δm of 0.2 or 0.3 — smaller than ADS 6499, which I'd just observed. The *WDS* magnitudes imply Δm = 0.5, but Worley's estimates during the 1980s average 0.2 also. In Webb's *Celestial Objects for Common Telescopes*, two pairs noted by Bird in this field are mentioned besides this one. They are not listed in the *WDS*, but visual inspection showed wide, faint pairs about 15' northwest and 18' southwest, forming a big triangle with ADS 7236.

As a staff astronomer at Lowell Observatory in Flagstaff, Arizona, Brian Skiff has the luxury of splitting doubles with the 24-inch Lowell refractor.

Scanning the Literature

Galaxies and Their Magnitudes, Part Four

by Brian A. Skiff

In this series of articles we've talked only about total magnitudes of galaxies: how they're arrived at, and how most galaxy catalogues lack homogeneity in providing this information. Unfortunately, as discussed last time, for the present we must live without well-defined magnitudes for most fainter objects, those below about magnitude 13.

In the first column of this series I mentioned briefly (and deferred discussion of) the subject of surface brightness as it pertains to galaxies. Let's now talk about this. Most observers know that the total magnitude alone does not provide an accurate prediction of how easy or difficult a galaxy will be in a given telescope at a particular observing site. Objects that have relatively bright total magnitudes can be difficult if they are large: the light spreads out so much that any small region of the galaxy is rather dim. Conversely, a tiny, faint object can be easy to pick up at high power because its light is so concentrated.

Fortunately, it is possible to give a measure of this degree of light-concentration, called the mean surface brightness. Values for more than a thousand galaxies are listed explicitly in the *Second Reference Catalogue of Bright Galaxies* (*RC2*). They are expressed in units of magnitudes per square arcminute, yielding numbers not terribly different from total magnitudes, comfortable for visual purposes. More specifically, the value is for the light with the B (blue) mag. 25 per square arcsecond isophote, which is the level at which the dimensions for the galaxy are given in the *RC2*, and which I discussed in the second article of this series (Autumn 1990 issue). This brightness level includes about 90 percent of the total light of most galaxies, so the average surface brightness within this area is a good representation of how bright a galaxy will appear visually.

We'll have occasion below to express surface brightnesses in magnitudes per square arcsecond as well as arcminutes. Since there are 3600 square arcseconds in one square arcminute, a particular surface brightness expressed in these units will be 3600 times fainter — 8.9 magnitudes fainter — than one given in square arcminutes. Remember, magnitudes are not linear units, but logarithmic, -2.5 times the logarithm of the linear "intensity" units. Thus, a linear factor of 3600 in magnitudes is:

$$m = -2.5 \log(3600),$$
$$= -2.5(3.556),$$
$$= -8.891.$$

(The minus sign is necessary so that brighter things come out with smaller magnitudes.)

The basic reference you can make with galaxies is that the mean surface brightness in magnitudes per square arcminute will match the total magnitude if the galaxy is exactly 1'.0 by 1'.0 in size, or covers an oval one square arcminute in area.

As a general rule of thumb, galaxies with mean V surface brightnesses of 14.0 to 14.5 are quite difficult for moderate apertures, no matter what the total magnitude. Many low surface brightness dwarf galaxies fall in this range. But at only one magnitude per square arcminute brighter, we reach the range of the typical Shapley-Ames galaxy, those plotted on Tirion's *Sky Atlas 2000.0*. The commonly-viewed galaxy pair Messier 51 have surface brightnesses of V = 13.0 (for the Whirlpool) and 12.9 (the companion). Another Canes Venatici galaxy, the giant irregular NGC 4449, comes in at a surface brightness of V = 12.5. Few ordinary galaxies have higher surface brightness than 12.0 to 12.5.

In part two of this series I briefly mentioned that the night sky itself has a surface brightness of about V = 22.0 per square arcsecond (about 13.1 per square arcminute) at a site free of anthropogenic light pollution and when solar activity is not high. (A significant component of the night sky light is a "permanent aurora" called the airglow, which is stronger near solar maximum.) The question that immediately arises is: how can you see something that's fainter than a pure dark sky? The answer is: easy!

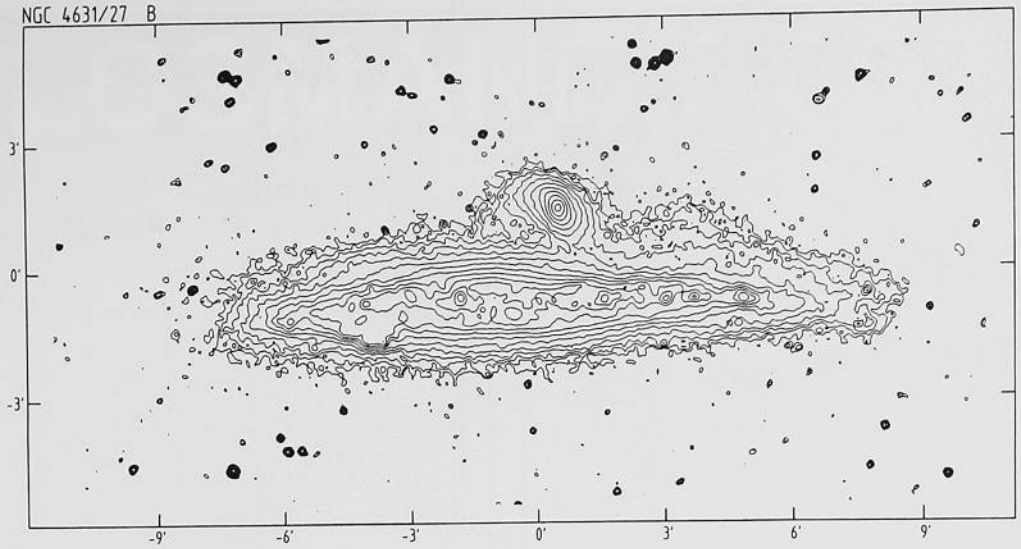
The brightness of a true-dark sky is nowhere close to the eye's detection limit. You can prove this with a couple of simple tests. First, at a dark observing site, hold your hand up against the sky. Which one is darker? That's right, the sky is gray, and if you're well dark-adapted, it is very bright compared to your hand. Now hold your hand down in front of you with the ground serving as the background. You can see the gross textural features of your hand pretty well, and yet it is being illuminated solely by the light of the sky: it is reflecting only a small portion of that light toward you and so must be fainter than the sky itself.

It's just a signal-to-noise problem: when some part of a galaxy has a brightness of magnitude 22 per square arcsecond (which is going to be near the center of a typical Shapley-Ames galaxy, by the way!), that just means it (the "signal") is bright as a dark night sky (the "noise"). But that spot will appear twice as bright as the background (0.75 magnitude brighter) because the skylight is included in the view. The limit then is obviously at some level much fainter than the sky, a level where your eye is not able to discern any additional brightness. The question, then, becomes: how faint can you go in terms of surface brightness — is it 50 percent of the sky, 10 percent, or what?

Here it's time to leave the theory for a moment and check the observations. From observations with my 6-inch refractor from both Lowell's Anderson Mesa site and from Las Campanas Observatory in Chile, I've found my limit on galaxies with published surface photometry to be between the V magnitude 23 and 24 per square arcsecond isophotes, or between B magnitude 24 and 25. Hey, those are familiar numbers! Recall that the standard isophote for galaxy dimensions is the B magnitude 25 isophote, about 15 times (three magnitudes) fainter than the night sky, or about 7 percent of the night sky brightness.

Indeed, this is consistent with laboratory determinations of the contrast difference the eye can discern at very low light levels when the two surfaces being compared are sufficiently large. The key here is "large." At low light levels, small brightness differences can only be discerned when objects are large. That's why you need high power to look at faint objects: not to "darken the sky" (that's false, because both the sky and object get dimmed by the same amount!), but to make the object large enough to see at low contrast — you have to use high power because most faint objects are small!

So, the sizes I get for galaxies, when I'm able to compare their extent carefully with field stars that I can measure later on the *POSS* prints, are only a lit-



This histogram shows surface photometry of NGC 4631/27 in B from three stacked plates. The resolution is 4."8, the lowest contour is μ_B = 26.0 magnitude, and the contour interval is 0.5 magnitude. Fifteen foreground stars hve been removed interactively.

tle smaller than the standard B magnitude 25 ones, or very close to the uncorrected *UGC* dimensions. A good example was my observation of NGC 5128, published in the letters section in the Autumn 1990 issue.

In terms of detection limits, some other examples might serve. Last winter I made a successful observation of Holmberg II, a dwarf irregular galaxy in the M81 group in Ursa Major, plotted on Uranometria as U4305. The *RC2* lists its total magnitude as V = 10.8 and the mean surface brightness as 14.8 per square arcminute, or 23.7 per square arcsecond. The total magnitude suggests it should be an easy object, one of the brightest few hundred in the sky. But it in no way could be called "easy" even from a dark site. In Chile, I observed ESO 422-G41, another dwarf irregular in Columba, marked as UA103 on *Uranometria*. According to *The Surface Photometry Catalogue of the ESO/Uppsala Galaxies* (*ESO-LV*), it has a total magnitude of V = 12.6 and mean surface brightness 13.8. In the 6-inch scope, it was a marginal object, and it was only because I noted the locations of some field stars that could be verified on the *POSS* that I am sure I saw it.

Again in Chile, I viewed ESO 371-G16, located in Pyxis. I had selected it before going down there based on its total magnitude (V = 11.7), neglecting to note the low surface brightness, 14.3. It was also a marginal object, and I noted in my logbook that I suspected the *ESO-LV* magnitude was incorrect for the extremely low surface brightness object. But upon returning home, I calculated the surface brightness and found it to be very faint, below my nominal cutoff for selecting objects to observe.

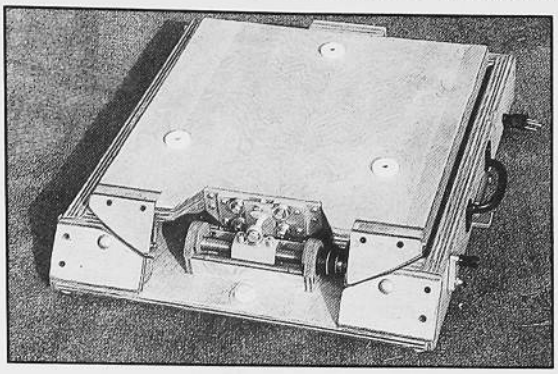
In summary, these examples show that I can spot objects with very low surface brightness (such as Holmberg II) when their total magnitudes are fairly bright, but at fainter total magnitudes, the mean surface brightness must be brighter for detection. The message here is that the two values, together with one's experience with a particular telescope/observing site combination, will give you a good idea of what to expect at the eyepiece, and particularly a much better idea than the magnitude alone.

Here is a final example, one that you can test your own observing skills on. The illustration shows surface brightness contours for the large, bright galaxy NGC 4631 and its companion NGC 4627 located in Canes Venatici. These are B-band isophotes but will serve for our purposes. The outermost complete contour corresponds to the B magnitude 26 isophote, somewhat fainter than the *RC2* contour. The contours are at 0.5 mag. intervals, so the third ring inward shows the standard dimensions. The *RC2* lists the size of NGC 4631 as 15'.1 by 3'.3, very close to what's indicated in the plot: the galaxy reaches about 7' east and 8' west from the zero mark on the horizontal scale. The *RC2* gives a total magnitude of V = 9.21, while the surface photometry here adds up to V = 9.30 — well within the uncertainties cited in both places, and in excellent agreement considering the differing sources of the observations. The mean surface brightness works out to 13.3 per square arcminute. The companion is a much more difficult object: total V = 12.6 and surface brightness 14.4, not unlike the marginal objects for the 6-inch mentioned above.

Now the fun part, and a challenge I submit to readers, is the connection between the two galaxies. Deep exposures show that the companion object has an extension toward the larger galaxy: they are weakly interacting. It is clearly marked in the contour plot, reaching a maximum brightness in the pinched portion between the galaxies of about B = 24 per square arcsecond, or 15 per square arcminute, or again, about V magnitude 14.5 per square arcminute. These figures suggest the bridge between the two galaxies should be just visible from an ideal site with a 6-inch scope, or perhaps with a larger telescope from a brighter site. Try it. What do you see? Be careful, and honest! Watch out particularly for any evidence of scattered light in the telescope making objects look fuzzier than they should. Can you avoid some of the glare by placing most of the big galaxy just outside the edge of the field (use a moderate apparent field eyepiece) and still see the bridge? I expect to see a lively letters column in future issues of the magazine with the results of your observations!

Brian Skiff is an avid student of the astronomical literature and has an immense library in his home. He is also an astronomer at Lowell Observatory and coauthor of the book Observing Handbook and Catalogue of Deep-Sky Objects.

EQUATORIAL PLATFORMS
FOR DOBSONIAN TELESCOPES OF ALL SIZES



THESE PLATFORMS ARE TRUE EQUATORIAL MOUNTS

By adding just a few inches to the height of your Dobsonian telescope, full MOTORIZED TRACKING CAPABILITY is attained. Wherever you point – using the smooth and stable Dobsonian movements – you are tracking, automatically and precisely. There is no field rotation – nor any need for a computer to perform complicated adjustments in altitude and azimuth.

An EQUATORIAL PLATFORM creates new observing opportunities:

- You will find yourself using higher powers more often – for a closer look and a darker sky background.
- Group viewing and star parties are enhanced. Everyone gets to enjoy the view, without constant image drift. Each object can be studied at length.
- Astrophotography beckons. Piggyback a camera on your telescope and shoot the Milky Way for up to an hour. Take high resolution photos of the moon and planets. And, with a Dual-Axis Platform, long exposure prime focus photography becomes possible.

For the latest fully illustrated brochure and price list, send $2.00 to:

EQUATORIAL PLATFORMS
11065 Peaceful Valley Rd.
Nevada City, CA 95959
(916) 265-3183 *(Evenings)*

Platform drive components available for telescope makers – ask for parts price list.

Enterprise Optics

Quality Optics Since 1979
For the Discriminating Amateur and Professional Astronomer

Newtonian and Cassegrain Optics
6″ to 24″

Over 25 Years Experience

1991 Complete Optics Catalog, Send $1.00 U.S. $2.00 Canada or Foreign, in U.S. Currency.

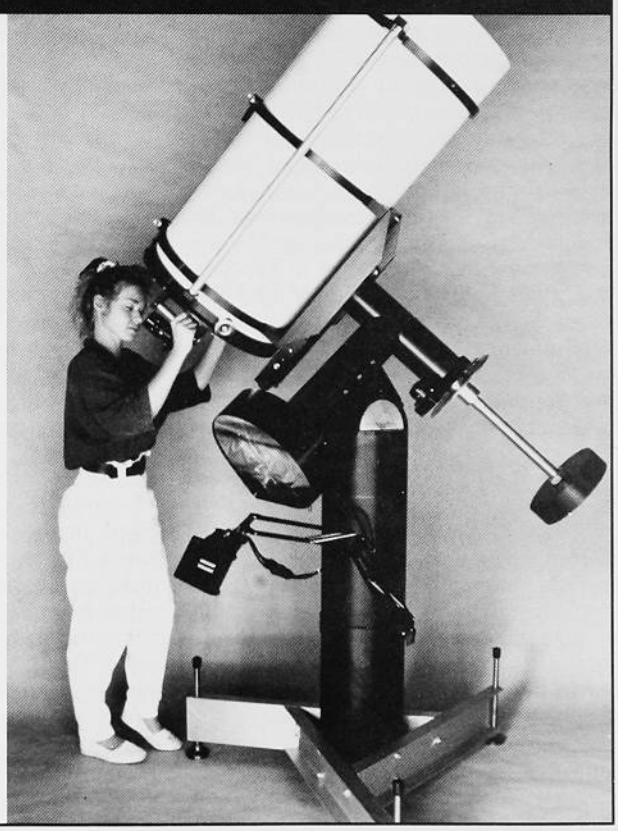
Enterprise Optics
P.O. Box 413, Dept. A
Placentia, CA 92670 USA
(714) 524-7520

THE RITCHEY-CHRETIEN ADVANTAGE

COMPLETELY COMA-FREE IMAGES!

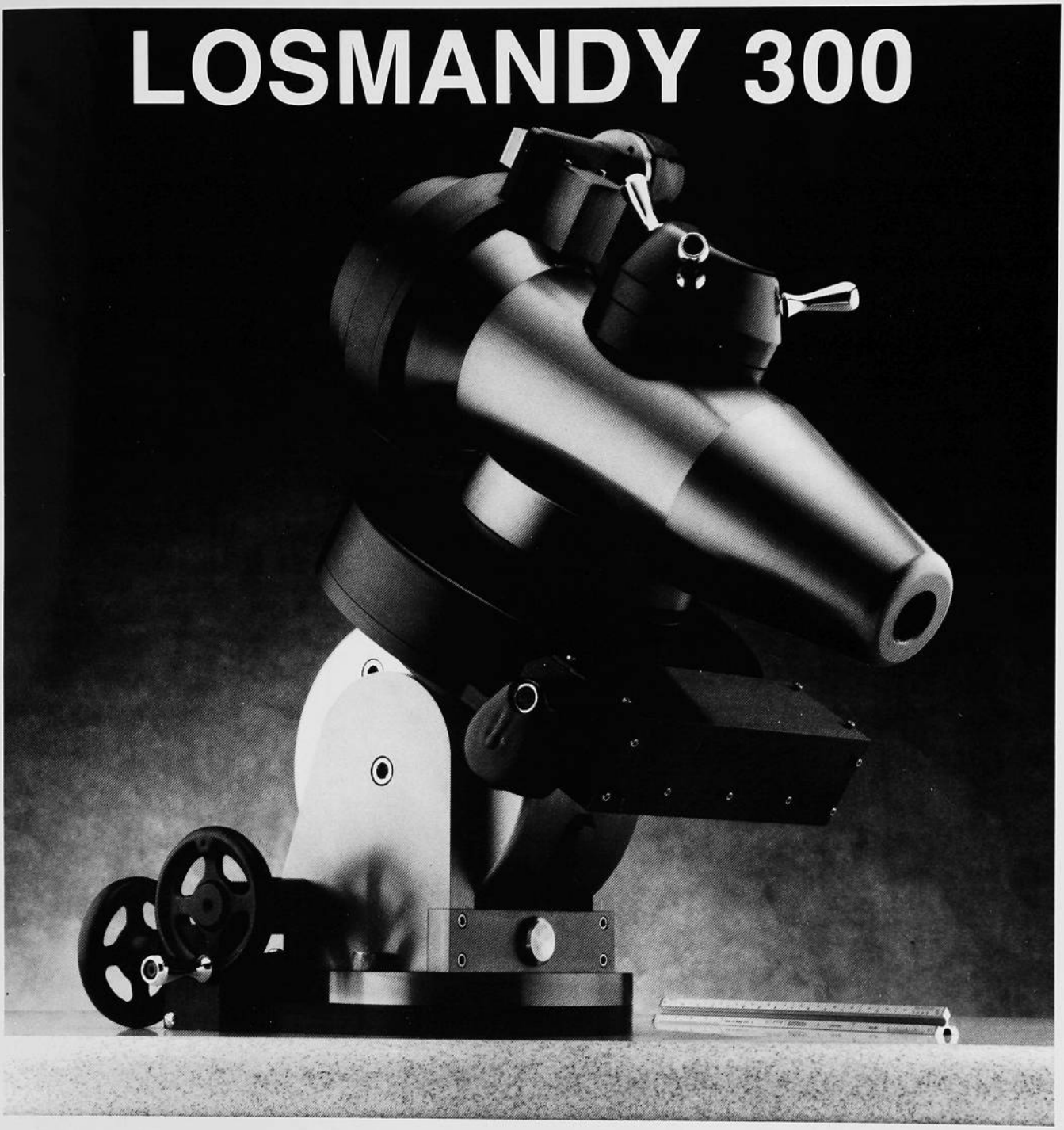
Professional astronomers require crystal-clear viewing. That's why they and state-of-the-art observatories demand the Ritchey-Chretien advantage. You, too, can achieve coma-free viewing and astrophotography (where stars *look* like stars, not comets or sea gulls!) with Optical Guidance Systems high-performance R-C telescopes.

Available from 10-32 inches
Shown: 16″ f/8.4 on HP75 mounting --- $13,550
Also available NEWTONIAN and CLASSICAL CASSEGRAIN telescopes (10-32 inches).



Optical Guidance Systems
2450 Huntingdon Pike, Huntingdon Valley, PA 19006
215-947-5571

LOSMANDY 300



LOSMANDY 300

- 3.00 Stainless Steel Shaft
- 7.00 Dia. Bearings
- 11.30 Worm Gear and Stainless Steel Worm
- Digital Setting Circles
- 300 lb. Instrument Weight
- Up to 500x Sidereal Rate Slewing
- Computer Control Capabilities

Prices from **$8995.00**

LOSMANDY 200

- 2.00 Stainless Steel Shaft
- 5.5. Dia. Bearings
- 7.5 Worm Gear and Stainless Steel Worm
- Digital Setting Circles
- 200 lb. Instrument Weight
- Up to 500x Sidereal Rate Slewing
- Computer Control Capabilities

Prices from **$5995.00**

Hollywood General Machining, Inc.

1033 N. Sycamore Ave. • Los Angeles, California 90038 • (213) 462-2855

SPECTRA*ASTRO*SYSTEMS

IS THE ONLY SUPPLIER OF THE SBIG ST-4 CCD STAR TRACKER/IMAGING CAMERA THAT *TAKES THE HASSLE OUT OF THE HOOKUP!*

"Simply the best way to get perfect round stars auto-guided while I enjoy the sky. Absolutely incredible to image 21.5 magnitude in 8 minutes! Blows right through the Palomar Survey."

Jack Newton

NGC-891 by Mike Stecker with C14@f6, on Hypered Tech-Pan
AUTO-GUIDED 90 MINUTES WITH THE SBIG ST-4

"I've been waiting for this ever since my 1st astrophoto. Now I don't pass up shots due to cold & fatique. I set up, get in my van, and warm up! ST-4 guides perfectly on comets too."

Mike Stecker

EXCLUSIVE SERVICE...WE PROVIDE EASY 'PLUG-IN' HOOKUPS TO MEADE, CELESTRON, TAKAHASHI, LOSMANDY, & OTHER HAND-PADDLES & JOY-STICKS

(Guaranteed to Function Perfectly) •*just...*$149• (Most Warrantees Remain Intact)

The model ST-4 is a dual-pupose instrument... a CCD Star Tracker & Imaging Camera!

Use it as a *'stand alone' Automatic Guider* to eliminate the drudgery of manual guiding & increase guiding accuracy of long exposure astrophotos.....And the ST-4 is a *Highly Sensitive Imaging Camera* when interfaced with a Computer!

MODEL ST-4 STAR TRACKER/IMAGER including:

- *Thermo-Electrically Cooled CCD Head*
- *Instrument Case with Keyboard*
- *LED Display*
- *Internal Micro-Processor*
- *Firmware & Memory*
- *Cables for Power, Hand-Paddle, RS-232*
- *Imaging & Analytical Software for MAC or PC (XT or AT comp.)*

only... **$890**

FAST DELIVERY & FREE SHIPPING
(In the Continental USA)

CALL FOR FREE 'UNIQUE PRODUCTS' CATALOGUE AND TO ORDER

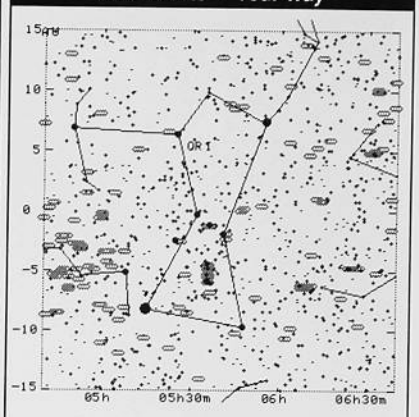
For Orders & Catalogues call FREE
800/735-1352
Tech-Talk call 818/343-1352
9 to 5 M-F (PAC TIME)
fax 24 hours: 818/996-7698

Spectra Astro • Systems™

CALIF RES ADD 6.5%
NO SUR CHARGE
VISA
MasterCard

6631 Wilbur Ave., Suite 30 * Reseda, CA 91335

SkyBase 2000.0 Plus SkyChart Ver 6
Star Charts - Your Way



REVERSED IMAGE STAR CHART OF ORION

Make custom star charts for observing aids, comet, deep sky objects, or photography
Plots charts Reversed Inverted Normal
You select RA and Dec - Center or Range and chart size. Use Constellation, Planet, NGC, or Messier Number for center.
ID of deep sky objects with mouse or cursor
Import data from your own databases

SkyBase includes: 48,000 stars thru Mag 7.9
8,000 objects from the *RNGC*
13,000 objects from *NGC 2000.0* database
(258,277 stars thru Mag 9.9 from SAO optional)

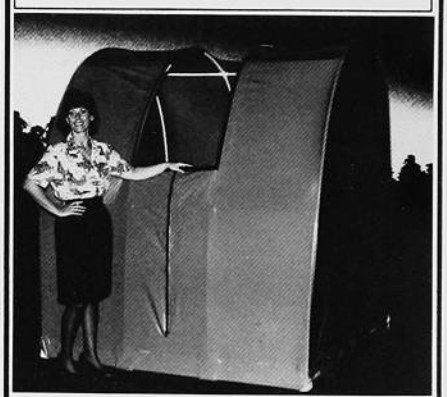
Order for only $64.95 - 258,277 stars $30 add'l
$4.00 S&H US, $10.00 Overseas Air Mail
(CA add 7% tax) Specify floppy size

IBM PC compatible w/640K; CGA, EGA, VGA; Epson dot matrix or HP LaserJet compatible printer, 80x87 optional

SkyBase Software and Computers
450 Spring Hill Drive Morgan Hill CA 95037

Super Dome

Portable/Permanent Observatory



The Ultimate Difference

between a superb astrophoto or none at all !

Easy to assemble
"User-friendly"
Convenient features

	SD-6	SD-8
fits all:	SCTs to 10" DOBs to 13" Newtonians to 10"	SCTs to 14" DOBs to 17" Newtonians to 16"
Price:	$298.00	$498.00
Shipping:	$25.00 U.S./Canada $65.00 foregn	$45.00 U.S./Canada $105.00 Foreign
Optional:	Roller system for easy rotation, $65.00 PPD	(fits either unit)

FREE BROCHURE: (702) 873-5790
Ace Dome 3186 Juanita Las Vegas NV 89102

"There will be a little less astrophotography done here."

-Tony Hallas & Daphne Mount, 20" owners.

Take a picture of this: portability, superb optics, ultra-smooth operation and exceptional craftmanship throughout. If you're serious about seeing, find out why nothing else even comes close to an Obsession 20" or 25" alt-azimuth telescope.

For a brochure that will get you Obsessed, send $2.00 to:

OBSESSION TELESCOPES
923 Stony Road #1, Lake Mills, WI 53551
· (414) 648-2328

LUMICON

HIGH PERFORMANCE TELESCOPE PARTS

LUMICON® SKY VECTOR™- *NEW!*

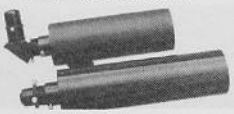
Computer-Controlled Digital Setting Circles, from $498

Incredibly Smart! thus Incredibly Easy!

- Digital right ascension readout to 1 minute of R.A.
- Digital decl. readout to 10 arc-min
- 2X higher resolution encoders
- Polar alignment **not required!**
- Motor drive **not required**
- Just sight two stars!
- Works for alt-azimuth **and** equatorial mounts

LUMICON Sky Vector™ (state scope) **$498**
Sky Vector™ Kit (you supply hardware) **$459**
Pair digital shaft encoders (for 2nd scope) **$149**

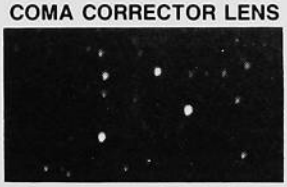
LUMICON 50mm, 80mm SUPER-FINDER™



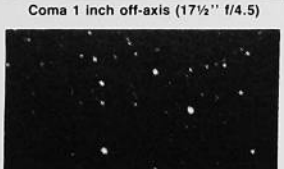
Visual Astronomers perfer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F = 300mm coated achromat. The deluxe SUPER-FINDER uses an 80mm, F = 500mm air spaced achromat.

1¼" 50mm Finderscope **$59.50**, right-angle **$89.50**
1¼", straight-thru 80mm SUPER-FINDER **$169**
1¼" right-angle version, w/star diagonal **$195**
1¼" Deluxe right-angle Super-Finder **$279**
25mm Cross-hair 1¼" eyepiece (12X) **$29**
1¼" Star Diag. . . . **$32**, 2" Star Diag., silver, . . **$159**
1¼" Amici Prism diag. for correct left-right views **$69.50**

COMA CORRECTOR LENS



Coma 1 inch off-axis (17½" f/4.5)



Same Field with LUMICON coma corrector lens; note smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. It threads into LUMICON 2" EASY-GUIDERS for effortless installation. This lens is optimized for f/4.5 and reduces aberrations for f/3.5 to f/5 Newtonians. Off-axis images are much smaller, making off-axis guiding far easier and yielding round pinpoint star images in photos. Since star images are sharp over a full 2¼" circle, you can use medium format cameras in addition to 35mm cameras. This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Although designed for photography you may also use this lens to improve image quality in wide-field viewing with low power eyepieces.

LUMICON Coma Corrector/Field Flattener
2" lens **$285.00**
Extension tube for viewing **$26**
2" Easy-Guider™ (state camera) . . **$169.50**

NEW! ENCHANCED SILVER DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 3.1" enhanced silver diagonal mirrors & 2" star diagonal.
The new LUMICON diagonal mirrors have a special enhanced silver coating with a protective overcoating for long life. Visible reflectivity is 98-99% compared to 86-89% for standard aluminum coated mirrors. The extra 10-12% transmission is like adding an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32" **$29.95** 1.52" **$34.50** 1.83" **$39.50**
2.14" **$49.50** 2.60" **$65.00** 3.10" **$89.50**

ENHANCED SILVER STAR DIAGONAL

90° star diagonals with above enhanced silver mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.
1¼" (1.32" mirror) **$99.50**
2" (1.83" mirror)(see photo above) . . **$159.00**

OXYGEN-III FILTER

Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90% for both O-III lines at 496nm and 501nm.

Filter Type	1¼"	48mm
Lumicon Oxygen-III	$99.50	$199.50
Lumicon UHC	$99.50	$199.50
Lumicon Deep-Sky	$79.50	$119.50
Set UHC and Oxygen-III	$190.00	$380.00

NOTE: The Oxygen-III Filter is not a substitute, but a compliment to the UHC Filter. **1 year guarantee:** You must see nebulae with the O-III filter that are **invisible** without a filter.

NEW ADJUSTABLE PIGGYBACK MOUNT

LUMICON has just designed a new adjustable piggyback mount ideal for all telescopes of 8-14" aperture. It has **both** vertical and sideways adjustment to allow optical alignment. It was designed to allow mounting of the LUMICON SUPER-FINDER on C-8, C-14, etc., but is ideal for any telephoto lenses or small telescopes.

Deluxe Piggyback Mount **$54.00**
(State Telescope Type)
LUMICON 12x80mm SUPER-FINDER $195.00

NEW! LOW PROFILE HELICAL FOCUSERS

LUMICON® DELUXE NON-ROTATING HELICAL FOCUSER on a 6" telescope.

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.
Select your desired base-plate shape!
Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD, SUPER-FINDER base plate.
LUMICON 1¼" Helical Focuser **$49.50**
LUMICON 2" Helical Focuser **$59.50**
LUMICON Non-rotating Helical Focuser $89.50
3 handles (see photo) for non-rotat. focuser **$12.95**
2" Rack & pinion low profile focuser . . . **$129.00**
2"/1¼" adapter w/48mm filter threads . . . **$20.00**
2" LUMICON EASY-GUIDER **$169.50**

PROTECTIVE DUST COVERS

Protective plugs (left), vinyl dust covers.
Protect your valuable telescope optics, eyepieces and accessories with these black vinyl covers. Add $1 shipping. Deduct 10%, 2 or more sets.

1¼" O.D. plug, seals focuser . . . . . **4/$2**

2" O.D. plug	**2/$2**	3½" O.D. plug	**$1.50**
1¼", 1⅞"	**3/$2**	7½"	**$8**
1½"	**2/$2**	9½", 10.4"*	**$12**
2"	**2/$2**	12½", 12⅞"*	**$15**
3½", 4½"	**$5**	16"*	**$20**
5½"	**$6**	19" (DS-16)	**$35**
*Fits Odyssey		21" (Odyssey 17½)	**$35**

MAKE YOUR OWN ASTROGRAPH

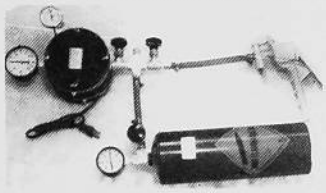
FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15X film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

†U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$295.00**



MODEL 600 HYPER-KIT (See Photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$350.00**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller **$595.00**

Temperature controller for any HYPER-KIT **$65.00**

Electric Vacuum Pump **$319.00**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms of bright guide-starts. *Specify Camera and Telescope type.*
U.S. Patent #4,448,500

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in secs. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER **$169.50**
3X Relay Diagonal (see photo) **$89.50**
Illuminated reticle eyepiece system . . **$99.50**
Guider for Hasselblad **$350**, Mamiya 645 **$199**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Dynamax-8. Includes 50mm achromatic lens for f/5.8 operation —3X shorter exposures! **Superb rich field viewing, too!**
CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad $185, Mamiya 645 **$98**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) . . . . . **add $99.95**
Adapter for Hasselblad adapter **$195**, Mamiya 645, **$119**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable L.E.D. illumination, dual crosslines, battery pack.

2. Cable release for long exposures . . **$9.95**

3. **LUMICON Quartz Drive Corrector . $219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.
Declination motor (state telescope) . . $99
NEW Deluxe Digital Qtz. Drive Correc. **$298**

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).

Film Type, 35mm	Exposures	Price
2415, Ultra-fine B&W, red sens.	36	$10.95
SR3200, fastest of all, color neg	24	$13.95
Konica SR400, fine gr. color neg	12	$10.95
3M 1000, fastest slide film	20	$12.95
Fujichrome RD100, fine gr. slide	24	$12.95
5072, color slides from negs	36	$6.95
D-19 B&W Developer	1 gal.	$6.95

LUMICON®
2111 Research Drive #5T Livermore CA 94550
For phone orders please call (415) 447-9570
LUMICON Products catalogue $2.
Foreign orders add $8 ($20 for HYPER-KITS)
California Residents add 6% tax.
Prices subject to change w/o notice.

Paracorr™ Eats Coma

At Last, a *Universal* Coma Corrector for Parabolic Mirrors

There's no question large aperture reflectors like John Vogt's excellent 30" f/3.8 produce deep sky views rivaling those I've seen in major observatories. But his scope, like yours, is limited in field sharpness. The main offender is coma, an aberration which makes stars look like blurry comets. Visually and photographically, the faster the scope the worse the effect.

If we compensate for coma before starlight reaches the eyepiece, then the best eyepieces will be used to fullest advantage, and a sharp full frame 35mm photograph is possible. In sum, my design goals were:

1. maximum reduction in coma and field curvature without compromising spherical aberration and color correction

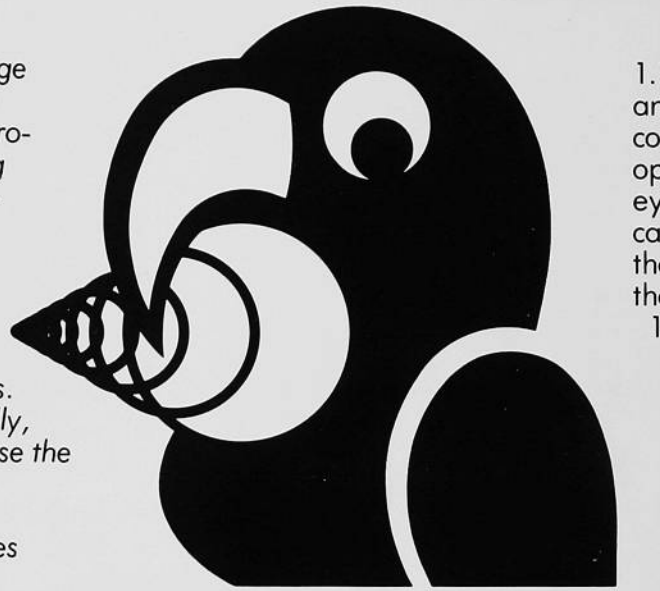
2. major sharpness improvement for all popular focal ratios

3. equally effective visually or for 35mm film

4. as convenient to use as a Barlow lens

I hope you agree that Paracorr, the coma eater, is the missing link necessary to fully enjoy your "DobNewt."

—Al Nagler



The Formula For Increasing Sharp Field

A perfectly made 13" f/4.5 parabola has only about .1° diffraction-limited field. Now add Paracorr plus a Nagler eyepiece to your f/3.5 – f/8 parabola and tremendously increase your sharp field. Extract all the performance the atmosphere and your mirror quality will allow. Since Paracorr tightens and intensifies star images, enjoy resolving globular clusters as they drift right to the edge of your field of view. No more finding the "sweet spot" of focus. The entire field is your "sweet spot"!

Astrophotography

Rival a Schmidt Camera? Mount your 35mm SLR to Paracorr, and the quality of full frame photos will be spectacular since star image sizes are designed to be less than .001 inch over the field for an f/4.5 mirror.

Easy To Use

Paracorr drops in like a Barlow lens. With only a slight 1.15x magnifying factor, an f/4.5 telescope becomes an f/5.17. While optimized for Tele Vue eyepieces, other makes can be used. Of course the better the eyepiece, the better the results. The 1¼" Paracorr is parfocal with most Tele Vue eyepieces. The 2" Paracorr requires about ½" in-travel from your current focus location. Can't be simpler for any scope, any eyepiece, and any 35mm SLR camera.

Paracorr — The Missing Link

An optical chain is as good as its weakest link. With the development of 82° Nagler eyepieces, Tele Vue offers the largest, flattest and best corrected visual fields in the industry. Combine the Nagler revolution, Dobsonian revolution and Paracorr for the ideal mating for flat-field and sharpness, visually and photographically. Try Paracorr on your "DobNewt." We think you'll agree that the revolution is complete.

A) parfocal 2"-1¼" adapter
B) 2" eyepiece holder
C) lens assembly threaded for T-rings

Paracorr — More stars, sharper stars, more time to observe. Send $3 for full line literature package.

Tele Vue™

20 Dexter Plaza, Pearl River, NY 10965
(914) 735-4044